WASHINGTON STATE ENERGY USE PROFILE

June 1996

Prepared by:

Policy Division
The Washington State Energy Office

Message from the Director

This edition of the *Washington State Energy Use Profile* is the seventh published by the Washington State Energy Office since 1979. The purpose of the Profile is to provide energy planners, policymakers, and consumers with information about energy-use trends in Washington State.

This version of the Profile departs from the format of its predecessors. Drawing on input from energy professionals and policymakers, a series of 10 energy performance indicators were developed for the Profile. The indicators combine energy, economic and demographic data in a manner that makes the information more meaningful and useful. Taken together, the indicators provide an overall look at the energy picture in Washington State.

We plan on making the Profile an annual publication. This will provide users with consistent energy information on a regular basis. The publication will be released in the spring each year.

There are a number of key energy trends highlighted in this issue of the Profile. Energy prices have declined from their peaks following the oil crises of the 1970s. Energy intensity has also declined due to improvements in energy efficiency and shifts in the economy to less energy intensive industries and businesses. The indicators for energy expenditures have returned to 1970 levels due to lower energy prices and reduced energy intensity. Amongst these positive trends are some areas of concern. One primary issue is the continued dependence on petroleum for over half of the energy consumption in the state. This is due to growth in transportation sector energy consumption, which accounted for over three quarters of the growth in energy consumption in the state during the period from 1983 to 1993. It is important to recognize and respond to these important trends to ensure we move into the future and don't relive the past.

As you may have heard, the Washington State Energy Office is closing its doors effective June 30, 1996. What you may *not* know is that, come July 1, 1996, new doors will open to you offering many of the programs, products, services and expert staff you've come to rely on, in addition to new programs you may want to learn more about. Energy policy activities will be moving to Washington State Community, Trade & Economic Development (CTED). CTED will be responsible for maintaining energy data for Washington State. The Washington State University Cooperative Extension will be providing these services under contract to CTED.

We are prepared to meet your energy information needs during this transition period. Please contact Alan Mountjoy-Venning, energy data research analyst at WSU Cooperative Extension, for your energy data needs at (360) 956-2092. For energy policy assistance, contact Deborah Ross at CTED at (360) 956-2124.

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EXECUTIVE SUMMARY

Washington residents and businesses spent $8.4 billion on energy in 1993. This constituted six percent of the gross state product. This 1993 value was about half the peak value of 11.6 percent in 1981 and was equivalent to 1970 levels. Total end-use energy consumption was 1,143 trillion Btu (Tbtu), comparable to levels in the period from 1990 to 1992.

Total end-use energy consumption in the state grew 51 percent between 1970 and 1993. Three quarters of this growth occurred from 1983 to 1990. Growth in transportation energy consumption accounted for 77 percent of the growth in total end-use energy consumption from 1970 to 1993. This growth was driven by a 135-percent increase in vehicle miles of travel, which resulted from population growth and a 53-percent increase in per capita travel. Since petroleum is the primary fuel used by the transportation sector, growth in transportation consumption has maintained the state's dependence on this fuel. Petroleum accounted for 51 percent of the energy consumed in Washington in 1993.

Average energy prices in Washington declined 38 percent in constant dollars from their peak in the early 1980s to 1993. Natural gas and gasoline prices led the decline. However, 1993 average energy prices were still a third higher than in 1970 (gasoline was the only major fuel with lower prices). Energy prices rose sharply from 1973 to 1975 during the first energy crisis and from 1978 to 1982 due in part to the 1978 Iranian revolution (this was the heyday of the Organization of Petroleum Exporting Countries). Washington state energy prices followed national price trends and historically were about 5 to 10 percent lower.

Energy intensity in the four end-use sectors (transportation, industrial, commercial, residential) declined from 1970 to 1993 as expressed by the energy intensity indicators selected for those sectors. Likewise, energy cost intensity for the sectors dropped from energy price induced peak levels in the early 1980s.

- Industrial energy consumption per dollar of gross industrial product declined 47 percent from its peak in 1972. Energy expenditures per gross industrial product in 1993 were 50 percent lower than in 1984, but were still 50 percent higher than 1970 levels.

- In the transportation sector, average highway vehicle fuel efficiency improved 36 percent from 1970 to 1993. The fuel cost of driving a mile declined 56 percent from 1981 to 1993. Overall highway energy expenditures declined 30 percent during this period, despite a 63 percent increase in vehicle miles traveled. The declines in cost were due to improved vehicle fuel efficiency and lower energy prices.

- Residential household energy consumption was 33 percent less in 1993 than the peak value in 1972. Household energy expenditures in 1993 were 26 percent less than the peak in 1983 and were equivalent to 1970 levels.

- Commercial sector energy consumption per commercial employee declined 26 percent from its peak in 1982, but was equivalent to the 1970 level. Commercial energy expenditures per commercial employee were 38 percent less in 1993 than the peak in 1982, but were 37 percent higher than in 1970.

Lower energy costs for businesses and consumers were due to reductions in energy intensity and energy prices. Decreases in energy intensity were due to improvements in energy efficiency and in economic trends such as the shift to lower energy intensity, high value added industries. The fact that energy intensity remained stable or declined during the late-1980s when the economy experienced moderate growth and energy prices were stable suggests that long-term gains in energy efficiency have been achieved.

Energy consumption per person in Washington State was relatively steady from 1970 to 1993. However, transportation energy consumption per person grew 32 percent during this period, while non-transportation energy consumption per person declined 23 percent. Historically energy consumption per person in Washington state has been 5 to 10 percent less than the rest of the United States. However, that trend reversed in the mid-1980s. In 1993, Washington State per capita consumption again dipped below the United State's. Both the United States and Washington State have per capita energy consumption that is more than twice as much as other developed countries like Germany, England and Japan and five to 10 times greater than that of the rest of the world.

Emissions of greenhouse gases due to the consumption of energy fuels increased 53 percent from 1970 to 1993. The rate of growth is greater than the growth in energy consumption because of increased reliance on fossil fuels. Fossil fuels are the greatest contributors to greenhouse gas emissions. The share of total energy consumption from renewable sources like hydroelectricity (which produces no greenhouse gas emissions) has declined.

INTRODUCTION

Purpose

The purpose of the Washington State Energy Use Profile is to provide information on energy use, consumption, and prices in Washington State in a manner that is useful to energy professionals, policy makers, and the general public. By highlighting energy trends in the state, the Profile increases understanding of energy issues and their importance.

What's In The Profile?

A series of 10 energy performance indicators developed by the Washington State Energy Office are presented in the Profile. The indicators are designed to show the important energy trends in the state. They combine energy consumption, expenditure, and price information with economic and demographic data, and national trends to present energy information in a useful format for comparison and trend analysis (the next section describes the indicators used). The data for each indicator are presented in graphical and tabular form along with a brief explanation of the indicator, the trends, what the trends mean and the data used to develop the indicator. The appendices contain the detailed energy, economic and demographic data used to develop the indicators.

How To Interpret The Information

It is important to recognize that the trends shown by the energy performance indicators are all interrelated. For example, energy prices directly influence energy expenditures (expenditures are equal to the price of energy multiplied by the consumption of energy) and indirectly influence energy consumption (high prices tend to discourage consumption). Economic and demographic trends strongly influence energy trends. Consumption may increase as population increases, but per capita consumption may decline. Likewise, a growing economy can lead to higher energy consumption, but consumption per economic benefit may decline.

Data are presented for the period from 1970 to 1993. A number of events occurred during this period which had a strong influence on energy consumption and expenditures in the United States. The first oil crisis was triggered by the Arab oil boycott of 1973. The Iranian revolution in 1978 was accompanied by rising oil prices and a period of high inflation during the late 1970s. The early 1980s were characterized by a sharp recession. Oil prices crashed in 1985. The late 1980s and early 1990s were a period of moderate economic growth and low inflation. Iraq's invasion of Kuwait in July of 1990 brought to an end a decade of declining oil prices. The effect was short-lived, however, and oil prices began to retreat even before the Gulf War got under way.

Where Do The Data Come From?

The energy data in the Profile are derived largely from Energy Information Administration (EIA) sources. EIA sources are used for several reasons. First, they provide consistency when making comparisons across fuels or with national trends. Second, the information is sufficiently detailed to tailor it to meet our needs. Third, EIA provides reliable and consistent time series information. Economic and demographic data are derived from Washington State sources and national sources of economic data.

KEY ENERGY PERFORMANCE INDICATORS

What is a Key Energy Performance Indicator?

The indicators are designed to show the key energy trends in Washington State. By watching them closely, we can gain an understanding of where we are and make better decisions about where we want to go. In some cases, the indicators combine energy, economic, or demographic information to create an index that illustrates energy intensity. For example, indicators for the residential, commercial, industrial, and transportation sectors illustrate energy consumption and expenditures relative to an appropriate economic factor for each sector. Other indicators are designed to show key energy trends by breaking down energy consumption and prices by type of energy or end-use sector.

Why Did We Develop Key Energy Performance Indicators?

The indicators were developed to gain a better understanding of the state's energy performance and trends in energy intensity. Users of energy data suggested that the energy information be presented in a manner that made it meaningful and useful. The energy performance indicators developed in the Profile are a response to this suggestion. Taken together, the indicators provide an overall look at the energy picture in Washington State.

What Indicators Did We Select and Why?

The energy performance indicators were selected using input from energy professionals in the region. Good indicators show the basic and fundamental relationships between energy and the long term quality of life in the state. They must be understandable and useful to policy makers and the public. They must be measurable. Consistent and reliable data must be available to create the indicators.

The selected energy performance indicators fall into two groups: overall indicators to show consumption, price, renewable energy, and energy emission trends and indices to show energy performance and intensity.

Overall Indicators

- **Energy Consumption by Major Fuel:** Consumption trends by major fuel (petroleum, natural gas, electricity and coal).

- **Energy Consumption by Sector:** Consumption trends by end-use sector (residential, commercial, industrial and transportation).

- **Average Energy Prices:** Average energy prices for natural gas, electricity, gasoline, and distillate oil and overall Washington State energy prices compared to national prices.

- **Greenhouse Gas Emissions:** Carbon dioxide emissions from energy sources indexed to 1990 levels.

Energy Intensity Indices

- **Energy and the Economy:** Energy expenditures and consumption relative to gross state product with comparison to national values.

- **Energy Consumption per Capita:** Annual energy consumption per Washington resident.

- **Residential Indicators:** Residential energy expenditures and consumption per household.

- **Commercial Indicators:** Commercial energy expenditures and consumption relative to commercial employment.

- **Industrial Indicators:** Industrial energy expenditures and consumption relative to industrial activity.

- **Transportation Indicators:** Highway transportation energy expenditures and consumption relative to vehicle miles traveled.

ENERGY CONSUMPTION BY MAJOR FUEL

Summary

Total end-use energy consumption for the most recent three-year period (1990 to 1993) showed minimal growth (less than one percent). This followed the period from 1983 to 1990, when energy consumption increased 36 percent (annual growth rate of 4.5 percent). Growth in petroleum consumption accounted for 57 percent of this increase. Petroleum is the dominant fuel used in Washington State, accounting for 55 percent of total consumption in 1993. From 1990 to 1993, natural gas was the only major fuel for which consumption increased. Natural gas use almost doubled from 1983 to 1993, although its share of total consumption in 1993 was still below 1970 levels. Moderate growth in electricity consumption during the 1980s slowed during the last four years.

Why Select This Indicator?

The total end-use energy consumption by fuel indicator identifies the fuels the state is most reliant on and changes in the mix of fuels used. The trends show growth rates (or declines) in consumption by type of fuel and how those rates are changing.

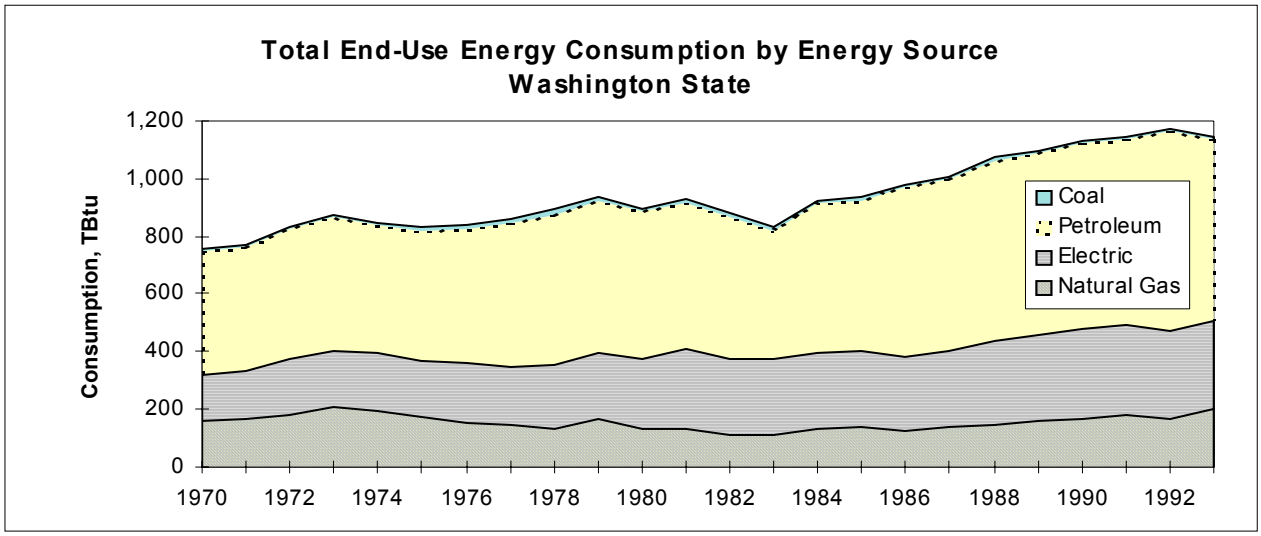
What Are The Trends?

It is useful to view the trends in total end-use energy consumption for three periods. The period from 1970 to 1983 includes two energy crises, high inflation, and a recession. There was a dip in consumption in 1983, followed by a period of steady growth. Beginning in 1990, consumption leveled off. Key trends include:

- In the 1970 to 1983 period there was strong growth in electricity use while natural gas consumption declined. This trend was reversed by 1990, with strong natural gas growth and a slight decline in electricity use.

- Petroleum consumption maintained a steady share of total consumption from 1970 to 1993. Total consumption closely mirrored petroleum consumption with solid growth from 1983 to 1990, leveling off through 1993.

	1970 Share	*1983 Share*	*1993 Share*	*1970 - 1983 Annual Growth*	*1983 - 1990 Annual Growth*	*1990 -1993 Annual Growth*
Natural Gas	21%	13%	18%	-2.6%	5.9%	6.2%
Electricity	22%	31%	27%	3.7%	2.5%	-0.2%
Petroleum	57%	54%	55%	0.3%	5.3%	-1.0%
Coal	1%	1%	1%	4.7%	-6.5%	-2.9%
Total	100%	100%	100%	0.7%	4.5%	0.4%
Total Primary	**114%**	**118%**	**108%**	**1.0%**	**3.6%**	**-0.7%**



	End-Use Natural Gas Consumption	End-Use Electricity Consumption	End-Use Petroleum Consumption	End-Use Coal Consumption	Total End-Use Energy Consumption	Total Primary Energy Consumption
Year	TBtu	TBtu	TBtu	TBtu	TBtu	TBtu
1970	158	163	429	6	756	862
1971	165	165	436	6	772	880
1972	180	194	453	4	830	964
1973	208	193	468	4	873	1,044
1974	191	203	447	7	848	1,026
1975	171	195	452	11	830	1,028
1976	155	209	462	15	840	1,049
1977	149	201	493	15	859	1,036
1978	133	223	519	16	892	1,095
1979	164	234	522	15	936	1,101
1980	134	238	514	11	898	1,051
1981	131	277	510	10	929	1,105
1982	114	258	498	12	882	1,040
1983	112	261	449	11	832	980
1984	132	267	514	9	922	1,094
1985	140	261	525	10	935	1,114
1986	122	258	591	9	979	1,130
1987	136	263	602	7	1,008	1,139
1988	149	290	625	8	1,072	1,179
1989	159	296	637	7	1,099	1,214
1990	167	311	646	7	1,131	1,257
1991	178	317	642	6	1,143	1,257
1992	169	305	692	5	1,171	1,268
1993	201	309	627	6	1,143	1,230

Sources:
Consumption -- Energy Information Administration

- Coal made up a very small portion of end-use consumption. Coal is an important primary fuel source in the production of electricity. This consumption is included in primary fuel consumption (see box entitled “Where does Electricity Come From”).

- Primary energy consumption trends are similar to end-use trends. Primary energy consumption measures the fuel consumed at power plants to generate electricity as well as fuels consumed by end-users (it does not include end-use electric consumption). Primary consumption is larger than end-use consumption because electric generation plants are less than 100 percent efficient (they consume more energy than they produce in electricity for end-use).

What Does It Mean

Petroleum is the dominant fuel used in Washington State. Overall consumption trends are largely driven by trends in petroleum consumption. The transportation sector uses the majority of petroleum consumed in the state. Thus growth in travel is a key influence on overall state energy consumption.

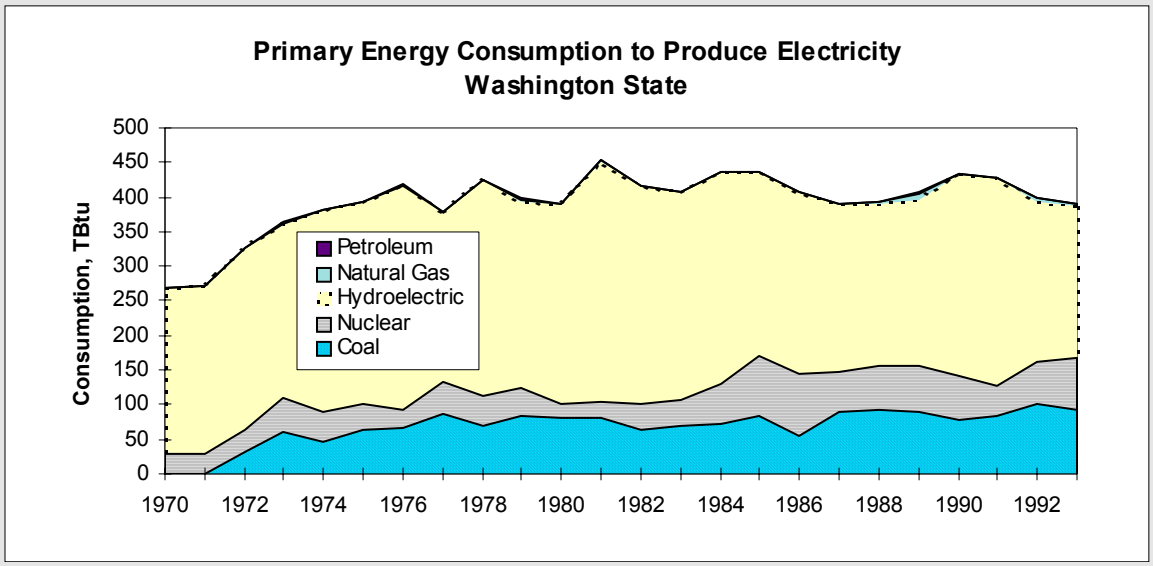
The increased popularity of natural gas for applications such as heating and industrial use since the mid-1980s are clearly reflected in the data. The decline in the growth rate of electricity consumption may be partly due to increases in efficiency and to fuel switching, primarily to natural gas.

About The Data

End-use energy consumption data are obtained from the Energy Information Administration (EIA). We adjusted EIA data to remove all non-energy uses of petroleum. Primary energy consumption includes the fuel consumed to produce electricity (such as coal) as well as fuel consumed by end-users. The Profile uses different conversion factors than EIA for determining the primary energy consumption attributed to hydroelectric plants (see Appendix D for more information).

Where Does Electricity Come From?

The end-use energy consumption data show how much electricity is used by consumers, but does not show the fuels used to produce the electricity. The consumption of primary energy for electricity production gives insight into the types of power plants used to generate electricity in the state.



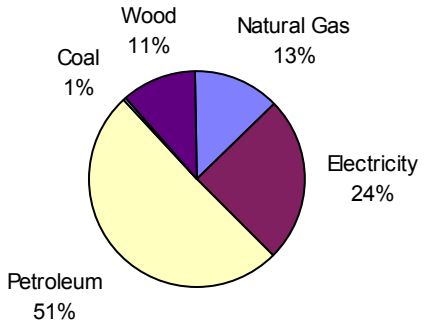
Hydroelectricity generation is the major source for electricity in Washington, although its share has dropped from 89 percent in 1970 to 56 percent in 1993. The Centralia coal-fired electricity generation plant came on-line in the early 1970s. In 1993, coal power plants accounted for 23 percent of electricity generation. Nuclear power contributed 19 percent of the state's electricity in 1993. Electricity production from natural gas and petroleum was minimal in 1993; however, electricity production from natural gas is expected to increase in the future.

Note that the primary energy consumption in Washington State does not include fuel used to produce electricity outside the state for utilities that serve Washington State consumers. It does include primary energy consumed in Washington State at power plants owned by utilities that largely serve consumers outside the state. Because the electricity grid throughout the Pacific Northwest and the Western United States is interconnected, viewing electricity generation only in Washington State is a limited perspective.

What About Wood Consumption?

Wood is used for home heating and as an industrial fuel in Washington State. Data on wood consumption are not consistently collected. It is difficult to measure wood consumption because the wood supply is widely dispersed, and there is no way to document wood purchases. It is important to recognize that wood use in Washington is significant, and the Washington State Energy Office has made some estimates of wood use. However, because these estimates are of limited duration, not regularly maintained, and less accurate than the energy estimates from the EIA, they are not included in the historical end-use energy tables.

End-Use Energy Consumption by Fuel (1990)
Including Wood (WSEO Estimate)



The chart shows that the magnitude of wood use was 11 percent of total end-use energy consumption in the state in 1990. Approximately three quarters of wood consumption occurred in the industrial sector (this includes wood pulp). The remaining wood consumption was for residential heating.

ENERGY CONSUMPTION BY END-USE SECTOR

Summary

Total end-use energy consumption was stable between 1990 and 1993. This followed rapid growth in the period from 1983 to 1990 and moderate growth between 1970 and 1983. Growth in energy consumption was due largely to growth in energy consumption in the transportation sector, which doubled from 1970 to 1993 and increased its share to over half of total end-use consumption. Industrial sector energy consumption experienced a modest decline during this period and its share of end-use consumption dropped from 36 to 22 percent. Together, the residential and commercial sectors have been responsible for approximately one quarter of total consumption during the past 25 years.

Why Select This Indicator?

The end-use energy consumption indicator shows which sectors are driving energy consumption in the state. The trends indicate changes in growth rates (or declines) in end-use consumption by sector and how those rates are changing.

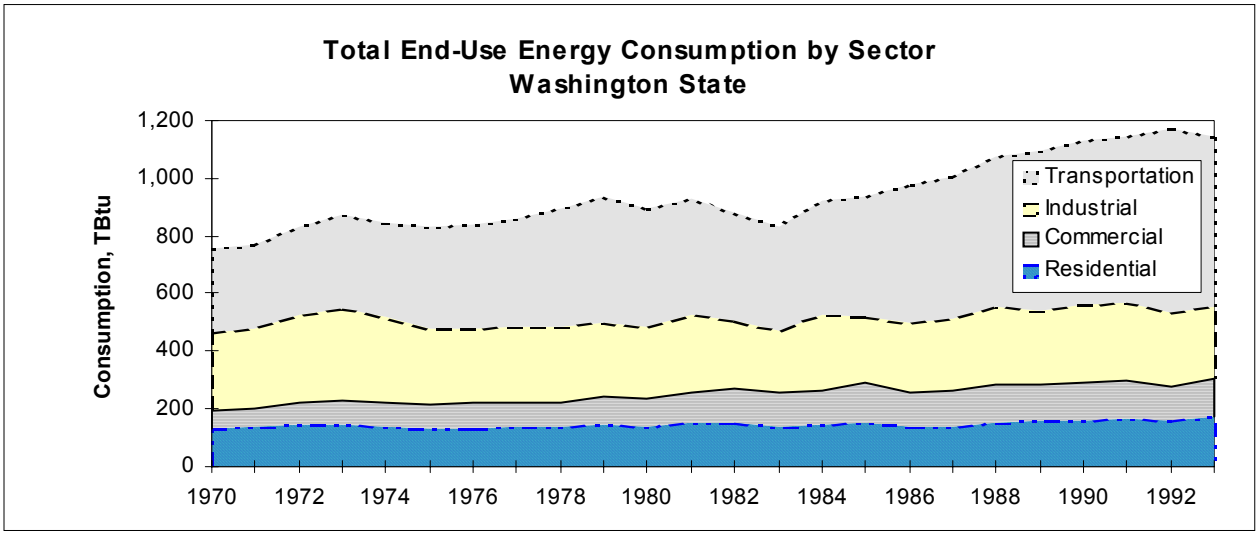
What Are The Trends?

Total end-use energy consumption increased 51 percent from 1970 to 1993. The trends in end-use consumption fall into three distinct periods. From 1970 to 1983 there were moderate levels of growth in total consumption. This growth accelerated between 1983 and 1990; much of the overall growth occurred during this period. Energy consumption increased in each of the end-use sectors. The growth in total end-use consumption leveled off after 1990. Key trends include:

- The most important cause of the overall increase in end-use consumption was a doubling of transportation sector energy use. Transportation increased its share of total consumption from 38 percent to 51 percent between 1970 and 1993. Growth in transportation energy consumption accounted for 77 percent of the growth in total end-use energy consumption during this period.

- Industrial energy consumption declined in both the 1970 to 1983 and 1990 to 1993 periods. It was the only sector to experience declines in consumption during these periods. The industrial share of end-use consumption declined from 36 percent in 1970 to 22 percent in 1993.

	1970 Share	*1983 Share*	*1993 Share*	*1970 - 1983 Annual Growth*	*1983 - 1990 Annual Growth*	*1990 -1993 Annual Growth*
Residential	17%	17%	15%	0.5%	1.9%	2.7%
Commercial	8%	14%	11%	4.9%	1.7%	0.5%
Industrial	36%	26%	22%	-1.9%	3.5%	-2.4%
Transportation	38%	44%	51%	1.8%	6.6%	0.9%
Total	**100%**	**100%**	**100%**	**0.7%**	**4.5%**	**0.4%**



	Residential Energy Consumption	Commercial Energy Consumption	Industrial Energy Consumption	Transportation Energy Consumption	Total End-Use Energy Consumption
Year	TBtu	TBtu	TBtu	TBtu	TBtu
1970	132	61	274	289	756
1971	138	66	272	296	772
1972	148	76	305	300	830
1973	144	87	315	327	873
1974	136	84	301	327	848
1975	132	82	266	349	830
1976	135	84	256	365	840
1977	139	86	259	375	859
1978	140	85	264	403	892
1979	148	93	260	434	936
1980	139	94	252	413	898
1981	149	105	272	402	929
1982	153	117	235	377	882
1983	141	115	213	363	832
1984	143	123	264	392	922
1985	152	138	234	412	935
1986	142	116	241	480	979
1987	139	122	251	496	1,008
1988	149	133	271	518	1,072
1989	157	127	255	560	1,099
1990	160	129	272	570	1,131
1991	168	131	267	577	1,143
1992	156	124	252	639	1,171
1993	174	131	253	586	1,143

Sources:
Consumption -- Energy Information Administration

- Commercial sector use more than doubled from 1970 to 1993. Much of the increase occurred prior to 1982. The commercial share of total consumption increased from eight percent to 11 percent.

- Residential sector consumption increased 32 percent from 1970 to 1993, but its share of total consumption dropped from 17 percent to 15 percent.

What Does it Mean?

The transportation sector consumed over half of the total end-use energy in Washington in 1993. This explains why petroleum consumption accounted for the largest share of fuel consumption. Increases in transportation energy consumption were due to increased travel. The decline in industrial consumption was due largely to changes in the economy and shifts to less energy intensive industries. The rapid population growth experienced by the state was the principal cause of increased residential sector energy consumption, while strong growth in the service sector was responsible for increases in commercial sector energy consumption.

About the Data

End-use energy consumption data are obtained from the Energy Information Administration. The data are adjusted to remove all non-energy uses of petroleum (see Appendix D for more information).

AVERAGE ENERGY PRICES

Summary

Average energy prices declined 38 percent in constant dollars from their peak in the early 1980s to 1993. Natural gas prices were less than half their 1982 level in 1993. Gasoline prices dropped almost 50 percent from 1981 to 1993. Electricity prices experienced a more modest decline: 17 percent from the peak in 1984 to 1993. Market factors and the deregulation of the natural gas industry were the drivers for these declines. Washington energy prices historically were about 5 to 10 percent lower than national prices.

Why This Indicator?

Average energy prices show how much it costs to purchase a unit of energy. The trends show historical changes in energy prices. Average energy prices provide a basis for comparison of prices consumers are paying within the state and relative to national prices.

What Are The Trends?

Average energy prices in constant dollars have declined significantly since the early 1980s. However, 1993 prices were higher than early 1970s prices for the major fuels except gasoline. Key trends include:

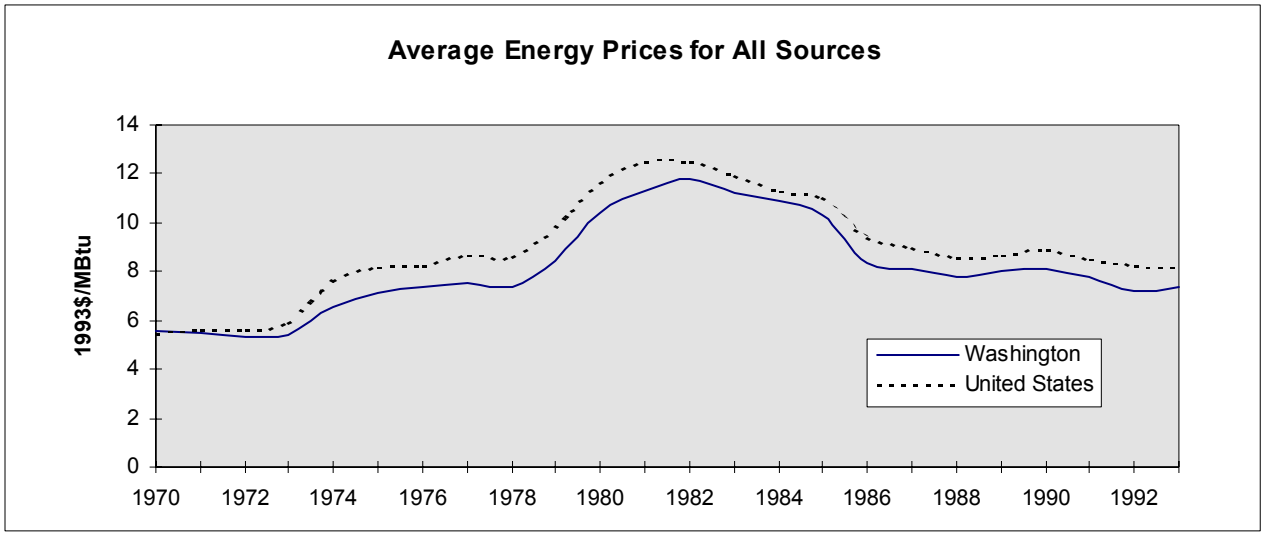
- Natural gas prices were the most volatile, increasing by almost a factor of four from 1970 to 1982, then declining by more than a factor of two.

- Electricity prices experienced a steep increase from 1980 to 1984, followed by a modest decline through 1992.

- Gasoline prices increased in the early 1970s during the energy crisis and from 1979 to 1981 during the second oil crisis. They declined until 1990 when the Gulf War took place, resulting in a brief upward tick in gasoline prices.

- Distillate oil, which consists primarily of diesel and heating oil, followed similar trends as gasoline. During the energy crisis in the early 1970s, distillate oil prices increased more rapidly than gasoline.

It is important to recognize the prices shown are averages across all customers. Typically, prices to large customers (like industries) are lower than costs for small customers (like residential households). Thus small customers are likely to find they are paying higher prices than the averages in the charts and tables, although the changes in their energy prices may be less dramatic.



	Natural Gas Prices	Electric Prices	Gasoline Prices	Distillate Oil Prices	Average Energy Prices (1993$/MBtu)	Average Energy Prices (1993$/MBtu)
Year	1993 cents/therm	1993 cents/kWh	1993$/gallon	1993$/gallon	Washington	United States
1970	21.9	2.36	1.30	0.58	5.54	5.51
1971	22.2	2.36	1.25	0.57	5.48	5.63
1972	22.6	2.36	1.18	0.57	5.30	5.65
1973	22.5	2.35	1.22	0.62	5.42	5.91
1974	26.5	2.21	1.51	0.90	6.56	7.58
1975	36.8	2.38	1.50	0.91	7.16	8.17
1976	43.3	2.26	1.48	0.94	7.33	8.26
1977	47.8	2.31	1.49	0.98	7.54	8.65
1978	49.6	2.17	1.44	0.95	7.40	8.61
1979	53.7	2.19	1.77	1.25	8.46	9.73
1980	69.7	2.43	2.21	1.64	10.38	11.64
1981	71.5	2.87	2.25	1.77	11.30	12.49
1982	83.4	3.77	2.03	1.75	11.82	12.52
1983	76.8	4.03	1.68	1.62	11.21	11.94
1984	73.0	4.24	1.64	1.53	10.85	11.32
1985	66.9	4.16	1.59	1.47	10.33	11.05
1986	55.4	4.05	1.21	1.08	8.32	9.40
1987	44.4	3.99	1.17	1.09	8.09	9.03
1988	44.7	4.02	1.13	1.06	7.81	8.61
1989	42.6	3.99	1.17	1.13	8.00	8.66
1990	36.5	3.67	1.31	1.23	8.13	8.94
1991	35.0	3.50	1.21	1.15	7.78	8.54
1992	36.0	3.46	1.22	1.10	7.18	8.23
1993	37.5	3.59	1.18	1.13	7.38	8.17

Sources:

Expenditures and Consumption -- Energy Information Administration

Price Deflator -- OFM, Forecasting Division, Washington Economic and Revenue Forecast

What Does It Mean?

A variety of market (supply and demand) and regulatory forces influence energy prices. Economic trends and world events can have a significant impact on the market and on regulatory policy. The deregulation of the natural gas industry in the early 1980s clearly affected natural gas prices. World events such as the energy crisis and Gulf War had a direct impact on oil and gasoline prices. The break-up of the OPEC oil cartel contributed to declining energy prices. Increasing competitive pressures in the electric industry and expected regulatory reforms will influence future electricity prices.

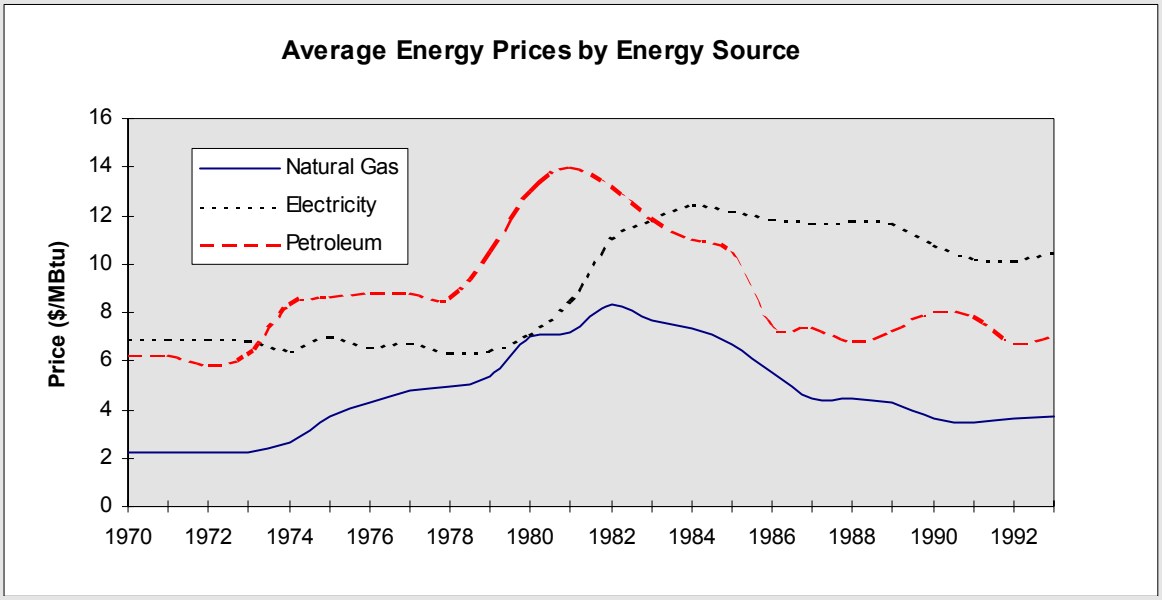
It is a common perception that energy prices in Washington are significantly lower than in other parts of the country. This is true for electricity, but the data show that the average price for all fuels (weighted by consumption) is only about 10 percent less. Other regions of the country with significantly higher electricity prices than Washington rely more on less expensive fossil fuels (see the box entitled “How Do Prices of Natural Gas, Electricity, and Petroleum Compare”). This difference in consumption patterns moderates the impact of higher electricity prices in other parts of the country on overall average energy price.

About The Data

Average energy prices are calculated by dividing total end-use energy expenditures by total end-use energy consumption. This is done for each individual fuel and for total energy. This results in an average energy price that is weighted by the amount of each fuel consumed. Energy expenditure and consumption data are from the Energy Information Administration (EIA). The EIA data are adjusted to remove expenditures and consumption for non-energy related petroleum products. (See Appendix D for more information.)

How Do Prices of Natural Gas, Electricity and Petroleum Compare?

The common units used to express the prices of different energy sources do not allow for easy comparison. Expressing prices in consistent energy units such as dollars per million British thermal units (MBtu) allows the prices of the fuels to be compared in terms of dollars per energy unit as shown in the chart.



Key trends for Washington State include:

- Natural gas was clearly the least expensive fuel.
- Electricity was very competitive in price with natural gas and petroleum prior to the increase in electricity prices which began in 1980. This was not true in other regions of the United States, where electricity is usually several times the cost of fossil fuels (natural gas and petroleum). Even after the increases in price in the early 1980s, electricity in Washington is less expensive than other parts of the country.
- Petroleum prices were the highest among the fuels in the late 1970s and early 1980s, but dropped below electricity in 1984.

The efficiency of the end-use appliance must be considered when comparing the costs for using different fuels. For example, a heat pump can have an average coefficient of performance of up to two (two units of heat are delivered for every unit of electricity consumed), while a natural gas furnace may have an efficiency of 80 percent. In this example, the cost per unit of delivered heat is $5.26/MBtu for the heat pump and $4.68/MBtu for the natural gas furnace using 1993 energy prices. The end-use costs are much closer than the prices for electricity and natural gas would suggest.

ENERGY AND THE ECONOMY

Summary

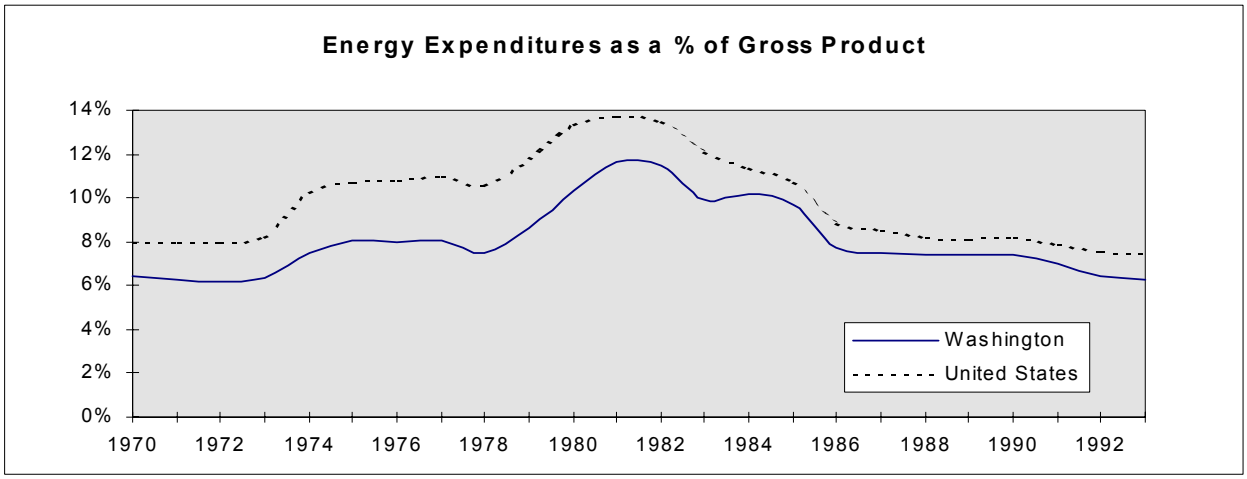
Energy expenditures as a percent of gross state product returned to early 1970 levels by 1992 after peaking in 1981 at 12 percent (nearly twice the 1970 value). Growth in the percentage was due largely to energy price increases that resulted in part from the energy crises of 1973 and 1978. The decline resulted from falling energy prices and a reduction in the energy intensity of the Washington economy. Washington energy expenditures as a percent of gross state product ranged from 10 to 30 percent lower than the United States as a whole. The gap was greatest in the late 1970s and returned to 1970 levels by 1992. Energy consumption per dollar of gross state product declined 26 percent from 1970 to 1993. This decline was due to increased energy efficiency and shifts to less energy intensive, high value added businesses (such as electronics and software). The Washington decline was less than the national value of 36 percent, but Washington energy consumption per dollar of gross state product was still eight percent lower than the national level in 1993.

Why Select This Indicator?

Gross state product is used as a measure of economic output. Dividing energy expenditures and consumption by gross state product provides a measure of the overall energy intensity of the Washington economy.

What Are The Trends?

Energy expenditures as a percentage of gross state product experienced two periods of strong growth. From 1973 to 1975 the percentage increased 26 percent and from 1978 to 1981 it increased 55 percent. These increases were offset by a decline beginning in 1982 that returned the indicator to 1970 levels. Most of the decline occurred between 1982 and 1986 when the percentage dropped 33 percent. Washington values were approximately 20 percent lower than the United States in the early 1970s. This gap grew to 30 percent in the mid to late 1970s, then narrowed to 10 percent in the late 1980s. By 1993 it had returned close to 1970 levels.



	Total Energy Expenditures Washington	Total Energy Expenditures United States	Energy Expenditures % Gross State Product	Energy Expenditures % of Gross Domestic Product	Energy Consumption/ GSP (kBtu/1993$)	Energy Consumption/ GDP (kBtu/1993$)
Year	billion 1993$	billion 1993$	Washington	United States	Washington	United States
1970	$4.19	$282	*6.4%*	7.9%	11.5	14.4
1971	4.23	292	*6.3*	8.0	11.5	14.2
1972	4.40	306	*6.2*	8.0	11.7	14.1
1973	4.73	331	*6.4*	8.2	11.7	13.9
1974	5.56	410	*7.5*	10.2	11.4	13.5
1975	5.94	426	*8.1*	10.7	11.3	13.1
1976	6.16	453	*8.0*	10.9	10.9	13.1
1977	6.47	480	8.0	11.0	10.7	12.7
1978	6.60	485	7.5	10.6	10.2	12.3
1979	7.92	550	8.6	11.7	10.2	12.1
1980	9.32	622	10.3	13.3	9.9	11.5
1981	10.49	654	11.6	13.8	10.3	11.0
1982	10.43	626	11.5	13.5	9.7	10.8
1983	9.33	585	9.9	12.1	8.9	10.1
1984	10.00	585	10.2	11.4	9.4	10.1
1985	9.66	567	9.7	10.7	9.3	9.7
1986	8.15	483	7.7	8.9	9.3	9.4
1987	8.16	480	7.5	8.6	9.3	9.5
1988	8.37	478	7.4	8.2	9.5	9.5
1989	8.80	487	7.4	8.2	9.3	9.4
1990	9.20	499	7.4	8.2	9.2	9.2
1991	8.89	477	7.0	7.9	9.0	9.3
1992	8.41	467	6.4	7.6	8.9	9.2
1993	8.43	476	*6.2*	7.5	8.5	9.2

Notes:

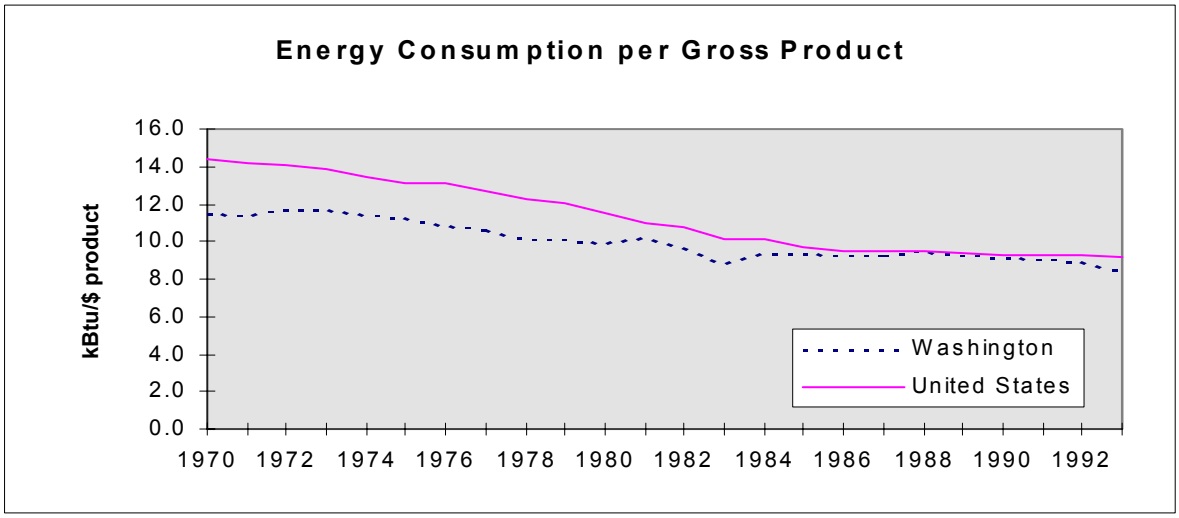
Values in italics are based on WSEO estimates of gross state product

Sources:

Expenditures and Consumption -- Energy Information Administration

Gross State and Domestic Product -- US Department of Commerce

Price Deflator -- OFM, Forecasting Division, Washington Economic and Revenue Forecast



Energy consumption per dollar of gross state product declined 26 percent from 1970 to 1993. The decline was relatively steady from the peak in 1973 (averaging 1.3 percent per year), although it leveled off in the 1978 to 1981 period and from 1984 to 1990. United States energy consumption per dollar of gross domestic product declined 36 percent from 1970 to 1993. The United States value was 25 percent higher than Washington's in 1970, but only eight percent higher in 1993.

What Does It Mean?

Increases in energy expenditures per dollar of gross state product were strongly influenced by energy price increases in 1973 to 1975 and 1978 to 1981 that resulted from the oil crises in these periods. These price increases affected petroleum most significantly, which is the fuel Washington State is most dependent on. There was a long term decline in energy consumption per dollar of gross state product from 1970 to 1993 that resulted from improvements in energy efficiency and shifts in the economy to less energy intensive, high value added businesses. This decline in energy consumption per gross state product coupled with energy price declines beginning in 1983 led to a decline in energy expenditures per dollar of gross state product back to 1970 levels.

About The Data

Energy expenditure and consumption data are from the Energy Information Administration (EIA). The EIA data are adjusted to remove non-energy uses of petroleum (see Appendix D). Gross state and domestic product data are from the US Department of Commerce. Gross state product was not available prior to 1977 or in 1993. These values were estimated based on the trends in US gross domestic product (which was almost identical to gross state product during the period of common record).

ENERGY CONSUMPTION PER CAPITA

Summary

Total energy consumption per capita in 1993 was similar to 1970 levels and to the historical average for the 1970 to 1993 period. Transportation energy consumption per person increased during the 1970 to 1993 time period and in 1991 exceeded non-transportation (residential, commercial, and industrial) consumption for the first time. This indicates that transportation energy consumption was growing at a faster rate than population and demonstrates the important impact of the transportation sector on increases in energy consumption. Conversely, energy consumption in the non-transportation sectors grew at a slower rate than population.

Why Select This Indicator?

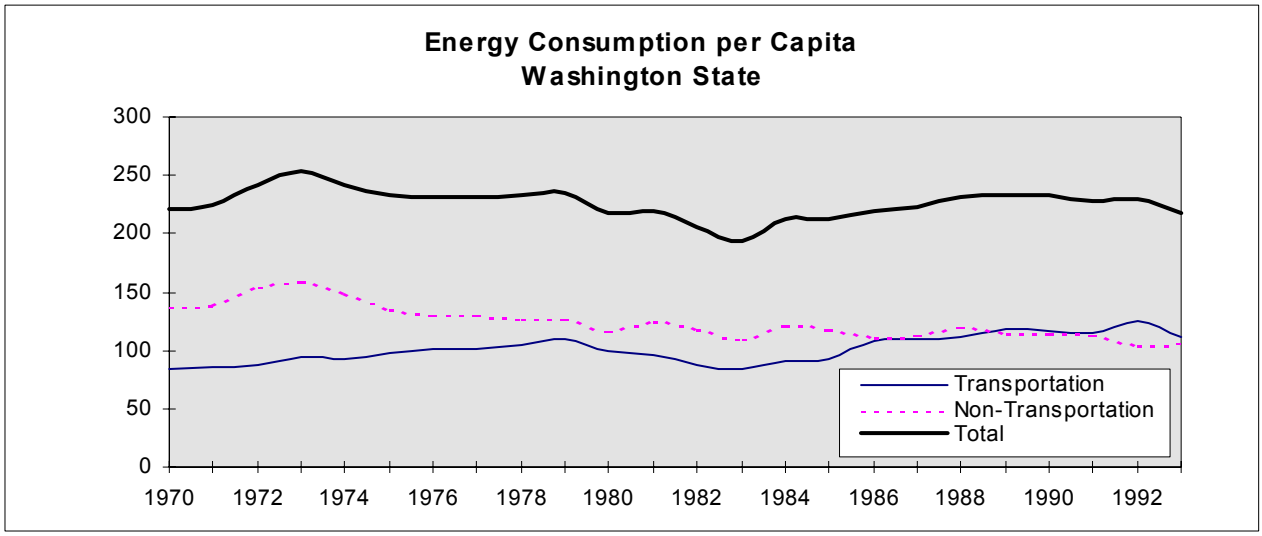
Examining energy consumption per person shows whether energy consumption is growing faster or slower than state population and provides an important indicator of state energy intensity trends. Separating transportation from non-transportation energy consumption is important for two reasons: 1) transportation-sector energy consumption accounts for the largest share of total energy consumption (over half); and 2) the infrastructure for delivering and consuming energy in the transportation sector is significantly different than in the residential, commercial and industrial sectors.

What Are The Trends?

Energy consumption in Washington increased by 51 percent from 1970 to 1993. However, total energy consumption per person was two percent less in 1993 than in 1970 and four percent less than the historical average for this period. Per capita consumption was highest in 1973 and lowest in 1983. Transportation energy consumption per person grew 32 percent from 1970 to 1993. Non-transportation energy consumption per capita dropped 23 percent from 1970 to 1993 and its share declined from 62 percent to 49 percent.

What Does It Mean?

Total energy consumption has grown at a similar rate as state population. The peak in energy consumption per person coincides closely with the period of lowest energy prices in the early 1970s and the valley corresponds to the peak in energy prices in 1982. Growth in transportation energy consumption per capita is driven by growth in travel per person (see the transportation indicators). The decline in non-transportation energy consumption is influenced by increases in energy efficiency and shifts to less energy intensive industries and businesses.



	Transportation Energy Consumption	Non-Transportation Energy Consumption	Transportation Energy Consumption per Capita	Non-Transportation Energy Consumption per Capita	Total Energy Consumption per Capita
Year	TBtu	TBtu	MBtu/person	MBtu/person	MBtu/person
1970	289	468	85	137	222
1971	296	476	86	139	225
1972	300	530	88	154	242
1973	327	546	95	159	253
1974	327	521	93	149	242
1975	349	480	98	135	233
1976	365	475	100	131	231
1977	375	483	101	130	231
1978	403	489	105	127	233
1979	434	502	109	126	235
1980	413	485	100	117	217
1981	402	526	95	124	220
1982	377	505	88	118	206
1983	363	469	84	109	193
1984	392	530	90	122	212
1985	412	524	93	119	212
1986	480	499	108	112	219
1987	496	513	110	113	223
1988	518	554	112	120	232
1989	560	539	118	114	233
1990	570	561	117	115	232
1991	577	566	115	113	229
1992	639	532	125	104	229
1993	586	557	112	106	218

Sources:

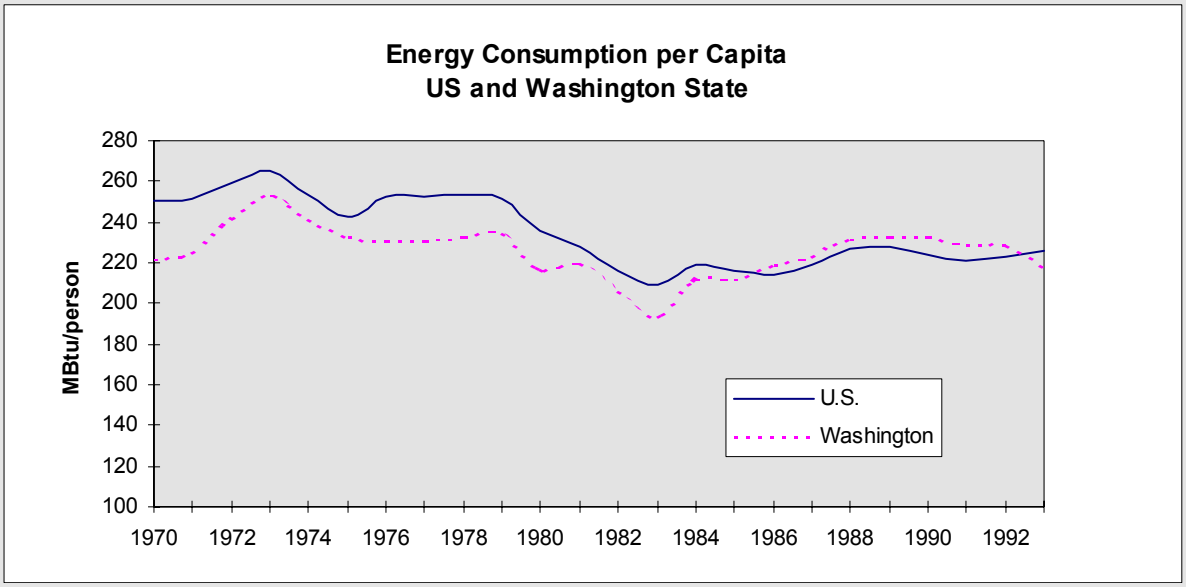
Consumption -- Energy Information Administration

Population -- OFM, Forecasting Division

About the Data

End-use energy consumption data are from the Energy Information Administration (EIA). The EIA data are modified to exclude consumption for non-energy uses of petroleum. Statewide population data are from the Office of Financial Management, Forecasting Division. See Appendix D for more information.

How Does Washington State Energy Consumption per Person Compare?



A common way to compare the energy consumption for different regions or countries is energy consumption per person. Energy consumption per person in Washington state was five to 10 percent less than in the rest of the country during the 1970s, but this trend reversed in the mid 1980s. For 1993, per capita consumption again dipped below the United States level. A number of factors can influence per capita energy consumption in a location:

- Energy intensity of industries: Some regions may have industries that consume large amounts of energy to produce goods that are exported from the region. This can inflate energy consumption per capita.
- Climate: Locations with severe climates tend to use more energy for heating, cooling and refrigeration.
- Economic Development: Ownership of energy consuming equipment, such as appliances and vehicles, and industrial development tend to be concentrated in wealthier regions, resulting in higher per capita energy consumption.
- Travel Characteristics: Transportation is a major contributor to energy use. Locations with high levels of travel, long travel distances, and limited public transit will tend to have high energy consumption per person.

- Efficiency: Countries with high energy efficiency are able to maintain quality of life with relatively lower levels of energy consumption per capita.

Characteristics of Washington State that influence per capita consumption include:

- Washington has a relatively mild climate and is blessed with an abundance of high quality hydroelectric energy.

- Washington has some energy intensive industries like aluminum, pulp and paper, and aerospace. Travel distances in Washington tend to be a little longer than in other parts of the country.

Energy Consumption per Capita (kilograms of oil equivalent)

	1965	1990
Canada	6,007	10,009
United States	6,535	7,822
England	3,483	3,646
Japan	1,474	3,563
Germany	2,478	3,491
Mexico	605	1,300
Brazil	286	915
China	178	598
Egypt	313	598
India	100	231

Source: World Bank. Word Development Report 1992. Table 5, p. 226-227.

Relative to the rest of the world, the United States and Washington have significantly higher levels of per capita consumption. Other developed countries such as Germany, England and Japan consume less than half the energy per capita as the United States. Much of the rest of the world uses five to 10 times less energy per person than the United States.

RESIDENTIAL SECTOR

Summary

In 1993, the average household spent $897 for energy used in their residence (this does not include household transportation energy use, see the box entitled “Household Energy Expenditures with Transportation). This is comparable to the $904 spent in 1970 (in constant 1993 dollars). During the early 1970s, household energy expenditures remained relatively stable despite increasing fuel prices. This was due to an 18-percent decline in household energy consumption from 1972 to 1975 and stable electricity prices. Household energy expenditures peaked in 1982 due to continued price increases coupled with only modest declines in household energy consumption. From 1983 to 1993 household energy expenditures declined 26 percent. This decline was due to a decrease in energy prices and a decline in household energy consumption. From its peak in 1972, household energy consumption declined 33 percent. This long-term decline without subsequent increases (despite lower energy costs) suggests that long-term gains in energy efficiency have been achieved in the residential sector.

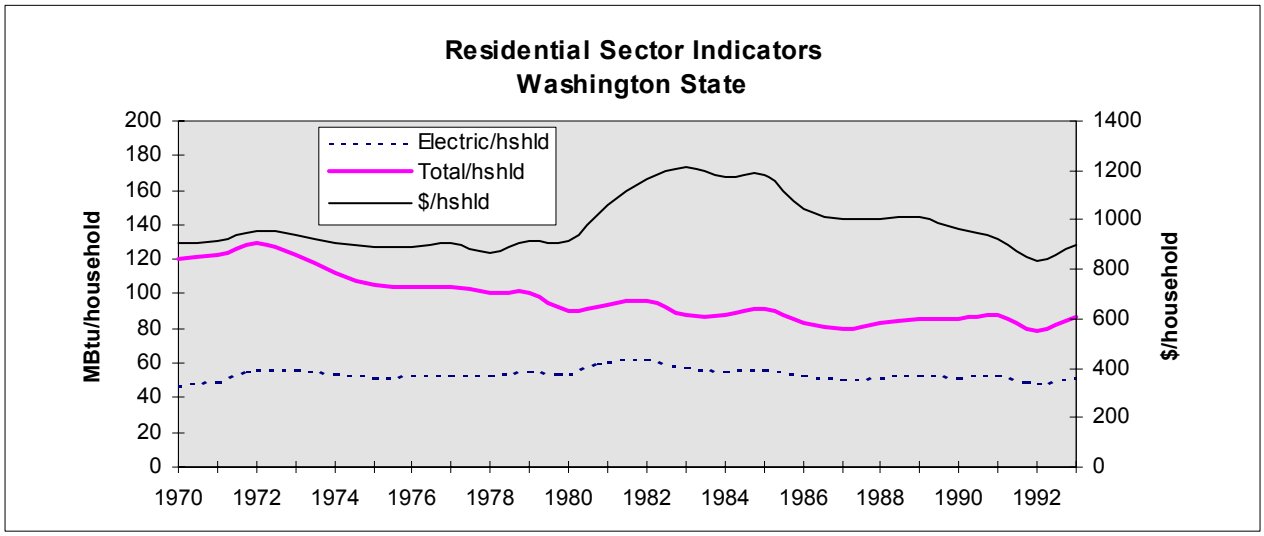
Why Select This Indicator?

The residential sector represents the energy consumption patterns of residents in the state and their direct energy expenses. The residential indicators are designed to show the trends in household energy use and energy costs. The residential indicators do not include household transportation energy consumption because historical transportation data for the residential sector are not available. The box entitled “Household Energy Expenditures with Transportation” includes estimates of transportation expenditures for 1990.

What Are The Trends?

Household energy consumption peaked in 1972, then declined at a 4.8 percent annual rate through 1976 and then at a moderate 1.8 percent annual rate through 1986. Household consumption was relatively stable from 1986 to 1993. Electricity consumption was fairly constant from 1971 to 1993, except for 1981 to 1983, when it peaked at 16 percent above 1993 levels. The electricity share of household energy consumption was 40 percent in 1970, peaked at 66 percent in 1983 and declined to 60 percent in 1993.

Household energy expenditures were stable from 1970 to 1980. Declines in household energy consumption helped to offset increases in energy prices. Continued increases in energy prices (particularly electricity) pushed household energy expenditures up 33 percent from 1980 to 1983. Household expenditures declined 26 percent from 1983 to 1993. Most of this decline occurred from 1985 to 1987 due to falling energy prices.



	Residential Electricity Consumption	Residential Total Energy Consumption	Residential Total Energy Expenditures	Residential Electricity Consumption per Household	Residential Energy Consumption per Household	Residential Energy Expenditures per Household
Year	GWh	TBtu	million 1993$	kWh/hshld	MBtu/hshld	$1993/hshld
1970	15,400	132	$1,000	13,900	120	904
1971	16,500	138	1,030	14,700	123	915
1972	18,900	148	1,100	16,500	129	958
1973	19,300	144	1,100	16,500	123	938
1974	19,400	136	1,100	15,900	112	904
1975	19,200	132	1,110	15,300	106	887
1976	20,300	135	1,150	15,700	104	889
1977	20,600	139	1,210	15,500	104	908
1978	21,900	140	1,210	15,700	101	869
1979	24,000	148	1,350	16,300	101	917
1980	24,400	139	1,410	15,800	90	915
1981	28,500	149	1,680	17,900	94	1,057
1982	29,200	153	1,870	18,200	96	1,167
1983	27,300	141	1,950	17,000	88	1,213
1984	26,700	143	1,920	16,300	87	1,171
1985	27,900	152	1,980	16,700	91	1,185
1986	26,500	142	1,770	15,600	84	1,041
1987	25,800	139	1,740	14,900	80	1,002
1988	27,200	149	1,800	15,200	84	1,007
1989	28,700	157	1,850	15,700	85	1,009
1990	28,800	160	1,810	15,400	86	967
1991	29,900	168	1,780	15,600	88	926
1992	28,400	156	1,650	14,400	79	835
1993	30,900	174	1,810	15,300	86	897

Sources:

Consumption and Expenditures - Energy Information Administration

Households -- U.S. Census Data and OFM, Forecasting Division

Price Deflator -- OFM, Forecasting Division, Washington Economic and Revenue Forecast

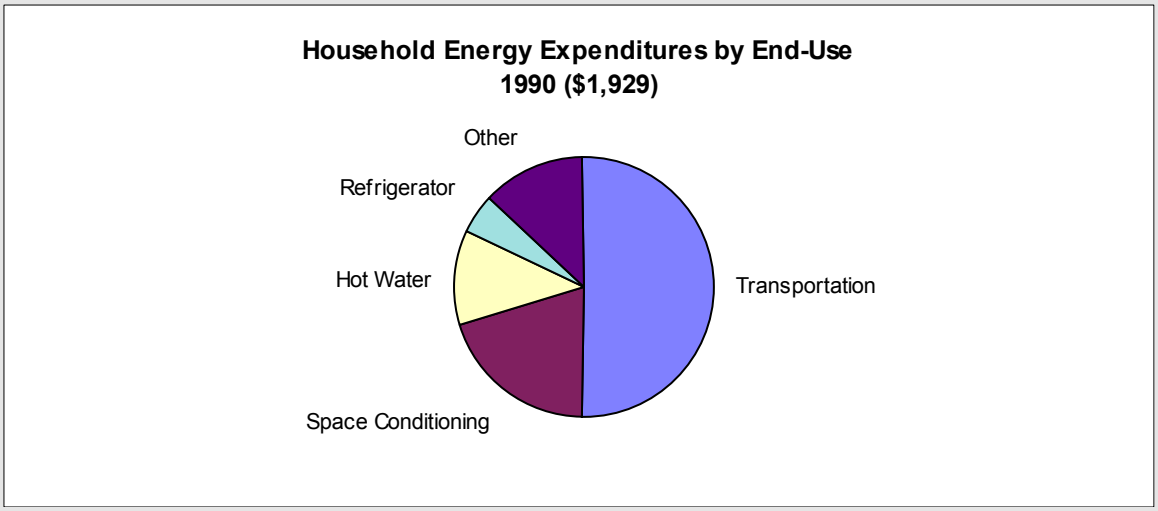
What Does It Mean?

Household energy consumption in 1993 was two-thirds of the peak in 1972. This decline in consumption seems to be strongly influenced by increases in energy prices, particularly in the early and mid-1970s. However when energy prices and household energy expenditures began to decline in the mid-1980s, household energy consumption stabilized and stayed relatively constant through 1993. Household consumption did not increase during this period, suggesting that long term gains in energy efficiency in the residential sector have been achieved.

About The Data

Residential energy expenditure and consumption data are from the Energy Information Administration. Household data are from the U.S Census Bureau.

Household Energy Expenditures with Transportation



Adding household transportation energy expenditures to household residential expenditures doubles total household energy expenditures to $1,929 (for 1990 in 1993 dollars). This reinforces the significance of transportation energy expenditures. The major residential expenditures in the home are for space conditioning (heating, cooling and ventilation), water heating and refrigerators. The “other” category includes lighting, clothes washers, dryers, and other household appliances. Note that the distribution of expenditures in the figure are estimates. They are most representative of a single family residence. The values for a particular household will vary depending on the efficiency of the home, its age and its size. Differences in household travel patterns can significantly affect the level of travel expenditures.

COMMERCIAL SECTOR

Summary

The energy cost intensity for the commercial sector (measured as energy expenditures per commercial employee) declined 38 percent from 1982 to 1993. During this same period energy consumption per employee declined 26 percent. This, along with a decline in energy costs, explains the decline in energy expenditures and suggests that gains in commercial sector energy efficiency were achieved during this period. Conversely, the period from 1978 to 1982 saw an increase in energy expenditures per employee of 82 percent. This resulted from a 24 percent increase in energy consumption per employee and an increase in energy prices. The increase in consumption is due to increased electricity use. The electricity share of commercial energy consumption grew from 37 percent in 1970 to 60 percent in 1993. Electricity consumption per employee increased 58 percent from 1970 to 1993, but declined 14 percent from its peak in 1982 to 1993.

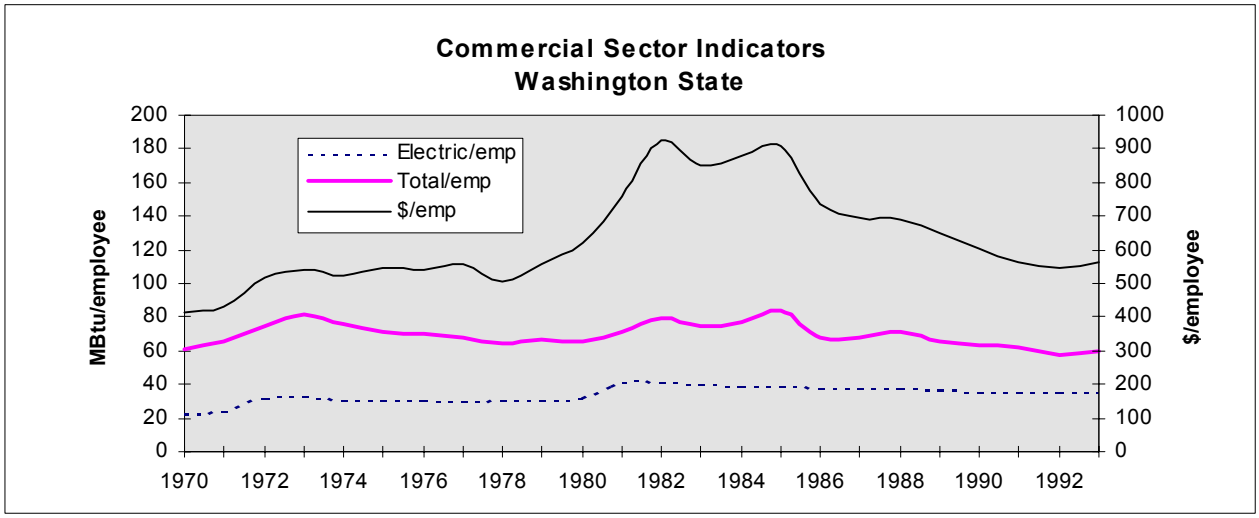
Why Select This Indicator?

The commercial sector includes service, wholesale and retail trade businesses, and government services in the state. The commercial sector indicators divide commercial energy consumption and expenditures by the number of commercial employees to show trends in commercial sector energy intensity. Note that square feet of commercial floor space is commonly used to measure commercial sector energy intensity. Commercial square footage was not used because of the lack of availability of consistent historical data for Washington State.

What Are The Trends?

Commercial energy consumption per employee increased 34 percent from 1970 to 1973 and 24 percent from 1978 to 1982. These increases were offset by a 28-percent decline from 1985 to 1993, which left energy consumption per employee in 1993 at a similar value to 1970. Gains in electricity consumption per employee accounted for 50 percent of the gains in total consumption per employee from 1970 to 1973 and 72 percent of the gain from 1978 to 1982.

Commercial energy expenditures per employee followed the consumption trends. Expenditures increased 32 percent from 1970 to 1973. This was due largely to increased consumption. The first oil crisis had little impact on energy prices for the key fuels used by the commercial sector. The 82 percent increase in energy expenditures per employee from 1978 to 1982 was influenced more by higher energy prices than greater energy consumption. Energy expenditures per employee dropped 38 percent from 1982 to 1993 leaving 1993 costs 37 percent higher than in 1970.



	Commercial Electricity Consumption	Commercial Total Energy Consumption	Commercial Total Energy Expenditures	Commercial Electricity Consumption per Employee	Commercial Energy Consumption per Employee	Commercial Energy Expenditures per Employee
Year	GWh	TBtu	million 1993$	kWh/emp	MBtu/emp	1993$/emp
1970	6,700	61.4	$420	6,630	60.7	411
1971	7,200	65.6	430	7,160	65.2	432
1972	9,700	76.3	530	9,510	74.8	516
1973	10,300	86.8	580	9,670	81.5	543
1974	10,100	84.2	580	9,060	75.6	524
1975	10,400	82.4	630	9,050	71.8	548
1976	11,100	84.3	650	9,250	70.2	543
1977	11,100	85.7	700	8,840	68.3	557
1978	12,100	85.0	670	9,110	64.0	506
1979	12,900	93.2	780	9,260	66.9	559
1980	13,800	93.9	890	9,560	65.1	619
1981	17,800	104.7	1,120	12,110	71.2	759
1982	18,100	117.0	1,370	12,230	79.1	923
1983	18,200	114.7	1,300	11,940	75.3	852
1984	18,000	122.8	1,390	11,350	77.5	878
1985	19,000	137.9	1,490	11,520	83.6	906
1986	18,800	115.6	1,260	11,020	67.8	737
1987	19,700	122.0	1,250	11,020	68.2	697
1988	20,700	133.5	1,290	11,060	71.3	690
1989	20,600	127.3	1,260	10,660	65.9	650
1990	21,500	128.7	1,230	10,550	63.2	602
1991	22,000	130.9	1,190	10,470	62.3	565
1992	22,500	123.8	1,170	10,490	57.7	546
1993	23,000	130.6	1,230	10,520	59.7	564

Sources:

Consumption and Expenditures -- Energy Information Administration

Employment U.S. Department of Commerce

Price Deflator -- OFM, Forecasting Division, Washington Economic and Revenue Forecast

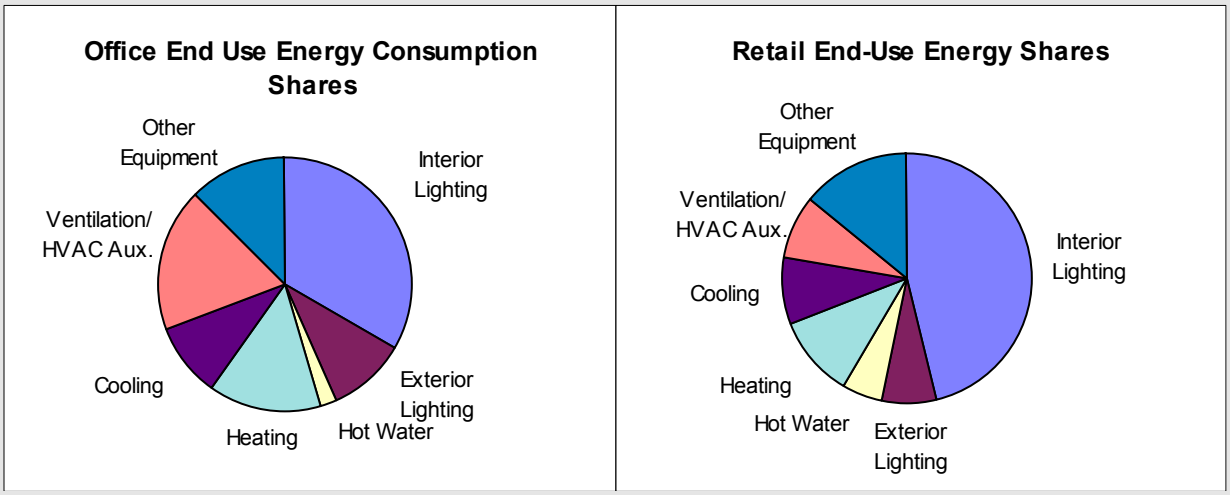
What Does It Mean?

Since 1985, the commercial sector has experienced significant gains in energy efficiency (as measured by energy consumption per employee). Increases in commercial energy-use intensity up to 1982 were driven by greater electricity consumption, likely due to increased use of electronic equipment and electric cooling. The trend of greater energy intensity did not continue after 1982 despite the increased penetration of computers and electronic equipment. This was also a period of declining energy prices. This suggests that improvements in energy efficiency were achieved during the 1980s.

About The Data

Commercial energy consumption and expenditure data are from the Energy Information Administration. Commercial employee data are from the US Commerce Department. Commercial data include wholesale and retail trade, financial, real estate, insurance, and other services, and government employment.

What is Commercial Energy Used For?



Lighting accounts for a major portion of commercial building energy consumption. The figure shows the distribution of energy consumption by end-use for commercial office and retail buildings in the Northwest. The shares are based on data from the End-Use Load and Consumer Assessment Program (ELCAP) funded by the Bonneville Power Administration. This study measured the end-use energy consumption from a sample of commercial buildings in the Northwest over a five year period. The average end-use shares shown in the figures are based on monitored data from 19 office buildings and 18 retail buildings. Note that end-use shares in commercial buildings can vary significantly. Restaurants are very energy intensive and have high cooking, refrigeration and heating, cooling and ventilation loads while warehouses tend to have low energy intensity with predominately lighting loads.

INDUSTRIAL SECTOR

Summary

Industrial energy intensity (energy use per dollar of industrial product) declined 47 percent from its peak in 1972 to 1993. This improvement in energy intensity was the greatest of any sector. However, industrial energy cost intensity was 50 percent greater in 1993 than 1970. This represents a greater increase in cost intensity than any of the sectors, indicating that energy prices in the industrial sector grew more rapidly than in the other sectors. Total industrial energy consumption declined 20 percent from its peak in 1972 to 1993. Electricity consumption grew, increasing its share of industrial energy consumption from 32 percent in 1970 to 49 percent in 1993.

Why Select This Indicator?

The industrial sector includes manufacturing, construction, agriculture, forestry and mining. Trends in industrial sector energy intensity are shown by dividing energy consumption and expenditures per dollar of industrial product.

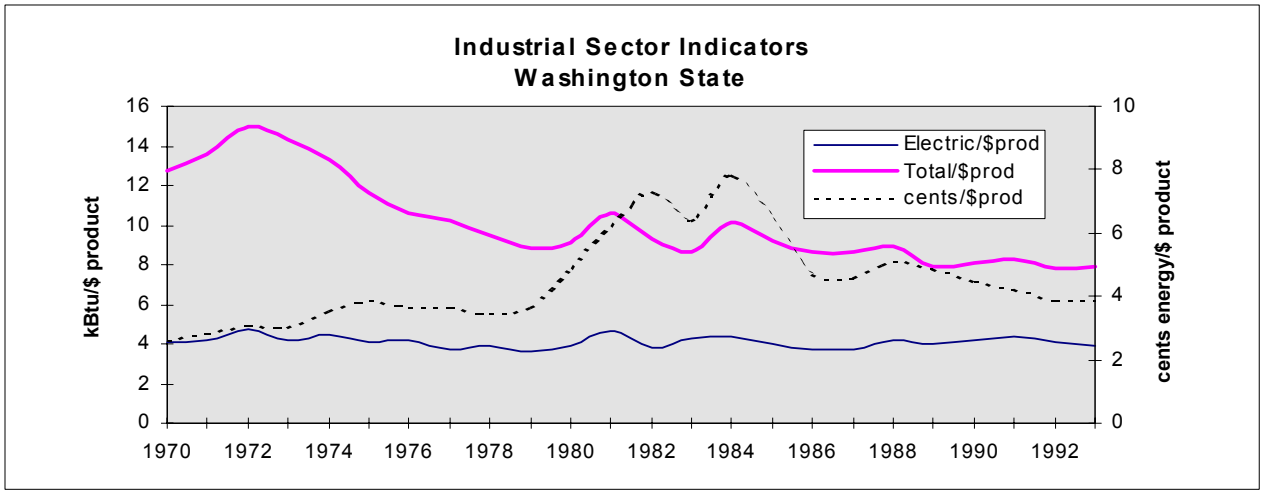
What Are The Trends?

Industrial sector energy intensity steadily declined from its peak in 1972. From 1972 to 1980, energy consumption per dollar of industrial product declined 39 percent, which corresponds to an annual decline of six percent. The rate of decline moderated to 1.1 percent per year from 1980 to 1993. Electricity consumption per dollar of industrial product remained relatively steady from 1970 to 1993. The electricity share of total consumption increased from 32 percent in 1970 to 49 percent in 1993. Note that total industrial energy consumption declined 20 percent from its peak in 1973.

Industrial sector energy cost intensity increased 50 percent from 1970 to 1975 and 111 percent from 1979 to the peak in 1984. By 1993, energy expenditures per dollar of industrial product had declined by 50 percent. Cost intensity in 1993 was 50 percent higher than 1970 in constant dollars.

What Does It Mean?

Industrial sector energy intensity declined 47 percent from its peak in 1972 to 1993. This was the most significant reduction in energy intensity of the four major sectors (residential, commercial, industrial and transportation). The improvement in energy intensity was driven by improvements in efficiency and shifts from energy intensive heavy industry to less energy



	Industrial Electricity Consumption	Industrial Total Energy Consumption	Industrial Total Energy Expenditures	Industrial Electricity Consumption per $ Product	Industrial Energy Consumption per $ Product	Industrial Energy Expenditures per $ Product
Year	GWh	TBtu	million 1993$	kWh/$	kBtu/$	1993 cents/$
1970	25,700	274	$559	*1.20*	*12.8*	*2.6*
1971	24,500	272	572	*1.23*	*13.6*	*2.9*
1972	28,100	305	627	*1.38*	*15.0*	*3.1*
1973	26,900	315	661	*1.23*	*14.4*	*3.0*
1974	29,900	301	808	*1.32*	*13.3*	*3.6*
1975	27,600	266	892	*1.21*	*11.6*	*3.9*
1976	29,800	256	886	*1.23*	*10.6*	*3.7*
1977	27,200	259	929	1.08	10.3	3.7
1978	31,500	264	969	1.13	9.5	3.5
1979	31,700	260	1,086	1.08	8.8	3.7
1980	31,500	252	1,332	1.14	9.1	4.8
1981	34,900	272	1,587	1.36	10.6	6.2
1982	28,400	235	1,834	1.13	9.3	7.3
1983	31,000	213	1,576	1.26	8.7	6.4
1984	33,500	264	2,040	1.29	10.1	7.8
1985	29,600	234	1,638	1.16	9.2	6.4
1986	30,200	241	1,314	1.08	8.7	4.7
1987	31,700	251	1,336	1.10	8.7	4.6
1988	37,000	271	1,550	1.22	8.9	5.1
1989	37,500	255	1,571	1.16	7.9	4.9
1990	40,800	272	1,501	1.21	8.1	4.5
1991	41,000	267	1,371	1.28	8.3	4.3
1992	38,500	252	1,245	1.20	7.8	3.9
1993	36,700	253	1,247	*1.15*	*7.9*	*3.9*

Notes:

Values in italics are based on WSEO estimates of state of industrial product.

Sources:

Consumption and Expenditures -- Energy Information Administration

Gross State Product -- US Department of Commerce

Price Deflator -- OFM, Forecasting Division, Washington Economic and Revenue Forecast

intensive, high product value industries (like electronics). However, industrial energy cost intensity increased more than any of the other sectors. This implies that energy prices for the industrial sector have increased more rapidly than the other sectors during this period.

About The Data

Energy consumption and expenditure data are from the Energy Information Administration. Gross industrial product information is from the US Department of Commerce and is converted to constant 1993 dollars. Gross industrial product information is only available for 1977 to 1992. Values for 1970 to 1976 and 1993 were estimated by WSEO using industrial employment trends to extrapolate the gross industrial product data. The trends for industrial employment and gross product were very similar from 1977 to 1992.

Industrial Energy Consumption from the Direct Service Industries

The direct service industries (DSIs) are so named because they purchase much of their electricity directly from the Bonneville Power Administration (BPA). This group of industrial firms in the Pacific Northwest are primarily electricity-intensive aluminum and primary metal industries. Twelve of the 19 plants are located in Washington. Washington plants represented 70 percent of the 3300 aMW BPA contracted capacity in 1995. The DSIs accounted for 20 to 25 percent of BPA's revenues from 1992 to 1995. In 1990, the DSIs consumed a little more than half of the industrial electricity in the state. This represented a little more than 20 percent of total electricity consumption in Washington.

TRANSPORTATION SECTOR

Summary

Energy consumption in the transportation sector has increased rapidly since 1970. Primarily because of increased vehicle travel, transportation energy consumption grew at the rate of 3.1 percent per year between 1970 and 1993. Vehicle travel in Washington State increased from 20 billion miles in 1970 to nearly 48 billion miles in 1993, an increase of 3.8 percent per year. This was only partially offset by increases in vehicle fuel efficiency. While vehicle travel grew by 135 percent, the fuel efficiency of the average highway vehicle increased only 36 percent between 1970 and 1993, from 12.2 miles per gallon in 1970 to 16.6 mpg in 1993. However, highway energy expenditures declined nearly 30 percent since 1981 due to a large drop in real gasoline prices. The combination of increased vehicle fuel efficiency and lower gasoline prices resulted in the average fuel cost of driving a mile declining nearly 56 percent from 1981 to 1993.

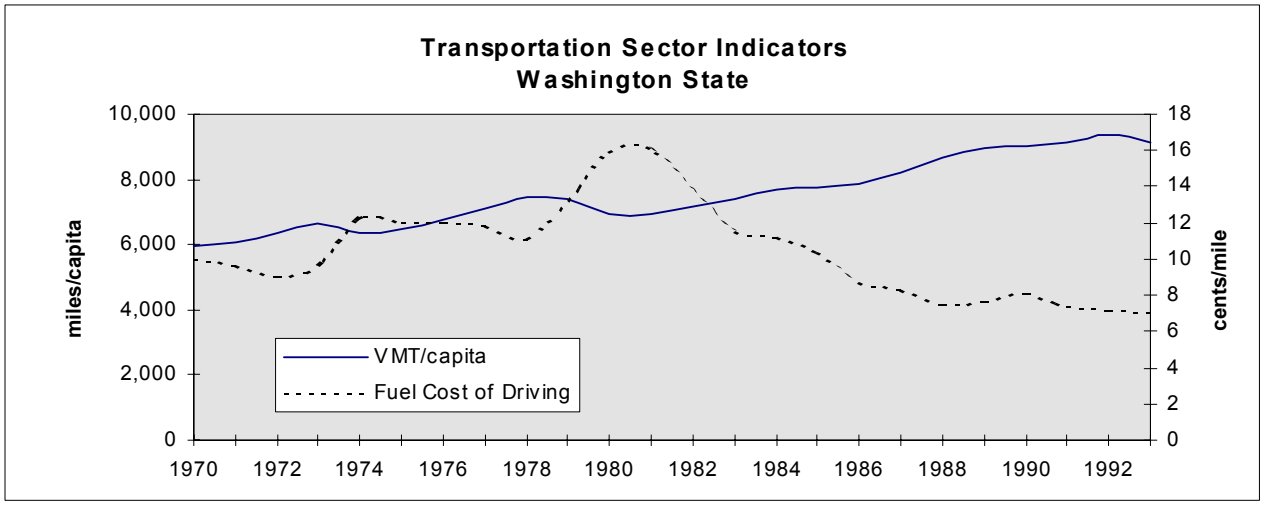
Why This Indicator?

The transportation sector indicators focus on highway fuel consumption. Highway vehicle fuels account for over 60 percent of transportation sector energy consumption, and are perhaps the most familiar trends to most people. The balance of transportation energy consumption is made up principally of jet fuel (22 percent) and residual fuel oil (14 percent).

What Are The Trends?

Vehicle miles traveled (VMT) have increased rapidly and steadily since 1970. Total VMT has increased more than two percent in each year except 1974, 1980 and 1993. On a per capita basis, VMT grew by more than 50 percent between 1970 and 1993, from nearly 6,000 to over 9,000 miles per Washington resident. Highway vehicle fuel efficiency has not kept up. From a low of 11.4 miles per gallon (mpg) in 1976, fuel efficiency has increased at 2.2 percent per year to 16.6 mpg in 1993.

Highway energy expenditures in the transportation sector reached a high of $4.8 billion in 1981 and have since declined by nearly 30 percent. The decline in highway fuel expenditures occurred despite the fact that VMT rose by 62 percent over the same period. This is due to the precipitous drop in gasoline prices over that period. Corrected for inflation, the price of gasoline dropped by nearly one half between 1981 and 1993. After peaking in 1981 at 16.2 cents per mile, the average fuel cost of driving a mile declined 56 percent to seven cents per mile in 1993.



	Vehicle Miles Traveled in Washington	Highway Energy Consumption	Highway Energy Expenditures	Vehicle Miles Traveled per Capita	Highway Miles per gallon	Fuel Cost of Driving
Year	million miles	TBtu	million 1993$	miles/capita	miles/gallon[1]	1993¢/mile
1970	20,370	208	$2,030	5,970	12.2	9.97
1971	20,840	215	2,010	6,060	12.1	9.64
1972	21,840	225	1,980	6,370	12.1	9.07
1973	22,980	244	2,190	6,670	11.8	9.53
1974	22,320	242	2,740	6,360	11.5	12.28
1975	23,110	250	2,800	6,480	11.6	12.12
1976	24,690	270	2,970	6,790	11.4	12.03
1977	26,490	283	3,130	7,130	11.7	11.82
1978	28,610	299	3,190	7,460	12.0	11.15
1979	29,510	294	3,870	7,420	12.6	13.11
1980	28,600	276	4,550	6,920	13.0	15.91
1981	29,450	279	4,760	6,960	13.2	16.16
1982	30,740	272	4,240	7,190	14.1	13.79
1983	31,970	278	3,690	7,420	14.4	11.54
1984	33,410	289	3,750	7,670	14.4	11.22
1985	34,260	285	3,580	7,760	15.0	10.45
1986	35,150	324	3,060	7,880	13.6	8.71
1987	37,210	334	3,110	8,220	13.9	8.36
1988	40,050	335	3,000	8,670	15.0	7.49
1989	42,430	352	3,280	8,970	15.1	7.73
1990	43,930	345	3,570	9,030	15.9	8.13
1991	45,540	349	3,360	9,110	16.3	7.38
1992	47,790	357	3,420	9,340	16.7	7.16
1993	47,890	360	3,370	9,140	16.6	7.04

Notes:

1. gasoline equivalent

Sources:

Consumption and Expenditures – Energy Information Administration

VMT -- Washington State Department of Transportation

Price Deflator -- OFM, Forecasting Division, Washington Economic and Revenue Forecast

What Does It Mean?

Energy consumption in the transportation sector continues to increase rapidly in Washington, despite gains in vehicle fuel efficiency. The reason is that people are simply driving more and more miles each year. Vehicle miles traveled per capita increased by over 50 percent between 1970 and 1993. This trend, combined with the rapid increase in the state's population during the same period, has resulted in total highway VMT more than doubling, from 20 billion miles in 1970 to nearly 48 billion miles in 1993.

The primary cause of the continuing growth in vehicle travel is the shifting land-use patterns that have characterized the United States and Washington State in the latter half of the 20th century. Rapid growth in suburban and, more recently, remote ex-urban areas has resulted not only in longer commute trips, but in longer trips to the grocery store, the movies, etc. These trends in land-use patterns would likely not have occurred without inexpensive gasoline. With the exception of the period between 1973 and 1985, when prices were inflated due to the influence of the OPEC cartel, real gasoline prices have been falling consistently since the Second World War (see box entitled "Gasoline Prices Since the 1950s"). With increasing fuel efficiency and improved vehicle technology, the real cost of driving has declined even more sharply.

Because increasing vehicle travel is a long-term trend due in large part to shifting land-use patterns, there is probably very little that can be done to reverse the trend. The fact that VMT per capita declined slightly after the oil shocks of 1973 and 1979 indicates that consumers do have some leeway to respond to increasing gasoline prices. However, as the chart shows, the large spikes in the cost of driving in those years resulted in very small declines in vehicle travel. These are just blips in the historical trend towards lower driving costs and higher vehicle travel.

About The Data

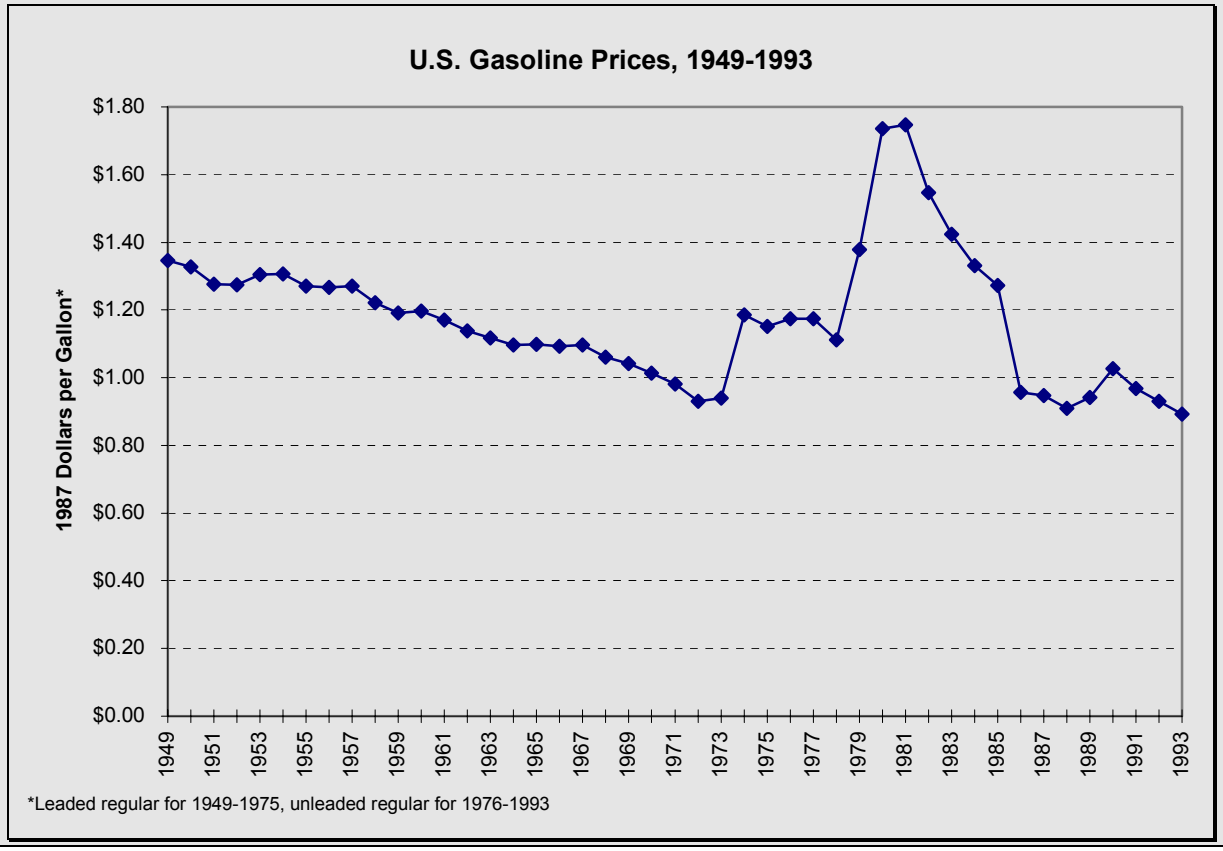
Highway energy consumption includes all gasoline and diesel used in the transportation sector. This necessarily includes small amounts of diesel used by trains and ferries. Energy consumption and expenditure data are from the Energy Information Administration, while VMT data are from the Washington State Department of Transportation. Fuel efficiency represents miles per gallon for all highway vehicles in the state, including trucks, buses and motorcycles as well as automobiles, and is determined by dividing total highway miles by total gasoline and diesel consumption. The fuel cost of driving is simply gasoline and diesel expenditures divided by vehicle miles driven.

Gasoline Prices Since the 1950s

It has been a common perception since the 1970s that gasoline today is more expensive than it used to be. Many people wistfully recall the days when gasoline cost 25 cents per gallon and nobody worried about gas mileage. Forgotten is the fact that the price of everything else has gone up too. Such recollections are colored by rosy memories of "the good old days" and bad memories of the OPEC price shocks. The reality is that, between 1950 and 1993, the price of gasoline relative to all other goods and services consumed by Americans declined by 33 percent.

Gasoline prices have experienced three distinct phases since 1950. Between 1950 and 1973, prices declined slowly and steadily as new fields were discovered and improved technology and infrastructure reduced the cost of extracting, transporting and refining crude oil. The period from 1973 to 1985 was the heyday of OPEC. During this period, marked by a boycott by Arab OPEC members in 1973 and the Iranian revolution in 1978, Saudi Arabia acted as a "swing" producer, adjusting its production to maintain high prices. In 1985, the Saudis decided they could no longer afford to curtail production, and the OPEC agreements fell apart. Prices immediately fell back to "pre-shock" levels. Aside from a minor blip caused by the Gulf War, the period since 1985 has once again witnessed slow and steady declines in the price of gasoline.

So despite the hubbub over the sharp rise in gasoline prices in the Spring of 1996, gasoline today is significantly cheaper than it was during the 1950s. Adjusting for inflation to 1987 dollars, a gallon of gasoline cost $1.33 in 1950, $1.20 in 1960 and $1.01 in 1970, as compared to $0.89 in 1993.



Source: Energy Information Administration, *Annual Energy Review 1993*, Table 5.22, p. 183.

GREENHOUSE GAS EMISSIONS

Summary

The burning of fossil fuel and wood produces greenhouse gas emissions, which contribute to global warming. As energy consumption in Washington State has increased, so have greenhouse gas emissions. In 1993 greenhouse gas emissions due to energy consumption were 53 percent greater than 1970 levels. The increase in emissions was due to the continued dependence in Washington State on fossil fuels, particularly petroleum. Over 90 percent of the growth in primary energy consumption from 1983 to 1993 was due to increased use of petroleum, coal, natural gas, and wood, the energy sources of greenhouse gas emissions. Over half the greenhouse gas emissions were from the consumption of petroleum. Production of electricity from hydroelectric and nuclear power plants produces no greenhouse gas emissions, but consumption from these sources has remained relatively constant.

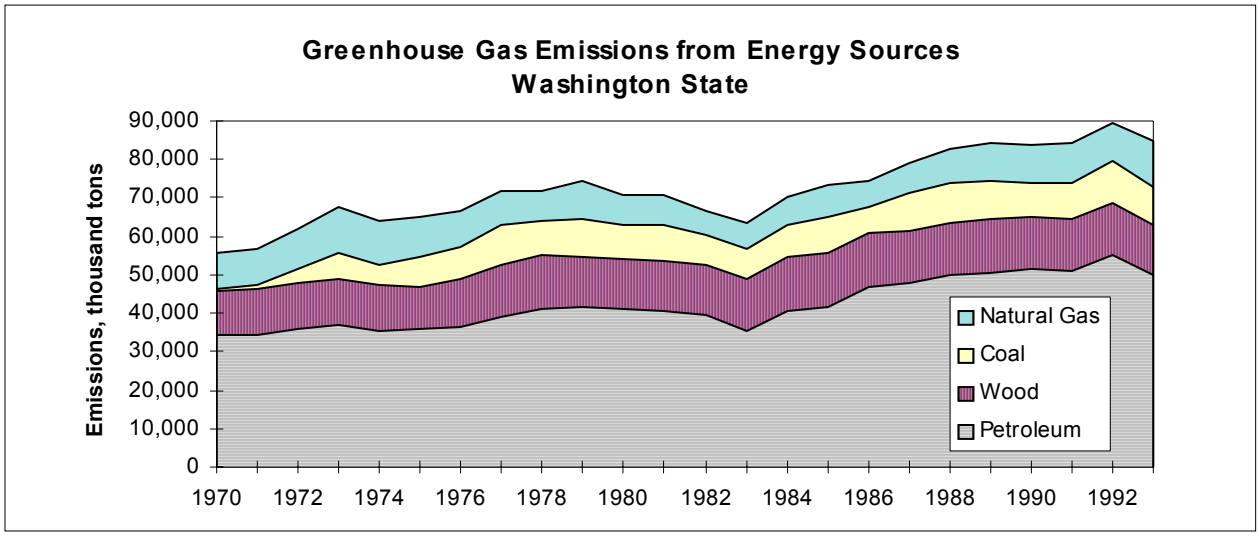
Why Select This Indicator?

Trends in greenhouse gas emissions give an indication of the impacts of energy consumption on one important environmental concern -- global warming. The trends show how changes in the mix of fuels consumed in the state affect greenhouse gas emissions and whether the state is making any progress in shifting energy consumption to low emission fuels. Greenhouse gas emissions are represented by the amount of carbon dioxide produced during the combustion of energy fuels. Note that greenhouse gas emissions are derived from primary energy consumption within Washington State. This includes the consumption of fuels within the state to produce electricity for electric utilities that serve customers outside the state. It does not include the consumption of fuels outside the state to produce electricity for utilities that serve customers within the state. Also, there are a variety of greenhouse gases emitted from non-energy sources within Washington State that are not included in this indicator.

What Are The Trends?

Greenhouse gas emissions from the consumption of fuels for energy have grown with energy consumption in the state. Emissions in 1993 were 53 percent greater than in 1970. This represents an annual growth rate of approximately 1.9 percent. This increase was greater than the 39 percent increase in primary fuel consumption during the same period.

The majority of greenhouse gas emissions were due to the consumption of petroleum. The share of emissions from petroleum consumption remained relatively stable -- it was 61 percent in 1970 and 59 percent in 1993. The shares of greenhouse gas emissions from wood, coal, and natural gas were similar, ranging from 12 to 16 percent in 1993. These shares have been relatively stable since the mid-1970s.



	Petroleum	Wood	Coal	Natural Gas	Total Greenhouse Gas Emissions	Emissions per Energy Consumption
Year	thousand tons	thousand tons	thousand tons	thousand tons	thousand tons	tons/GBtu
1970	34,142	11,774	595	9,210	55,720	63
1971	34,575	11,932	649	9,619	56,775	63
1972	36,058	11,922	3,713	10,466	62,159	65
1973	37,184	11,853	6,595	12,103	67,735	68
1974	35,524	11,643	5,498	11,134	63,799	66
1975	35,792	11,283	7,738	9,966	64,779	68
1976	36,550	12,541	8,242	9,014	66,348	68
1977	39,087	13,707	10,392	8,676	71,863	72
1978	41,221	14,090	8,600	7,760	71,672	69
1979	41,520	13,103	10,049	9,658	74,330	69
1980	41,118	12,737	9,232	7,884	70,971	69
1981	40,771	12,970	9,223	7,635	70,600	66
1982	39,632	12,949	7,518	6,659	66,757	66
1983	35,342	13,382	8,141	6,507	63,372	65
1984	40,680	13,768	8,352	7,681	70,481	66
1985	41,617	14,043	9,507	8,147	73,314	68
1986	46,999	14,011	6,423	7,088	74,522	66
1987	47,729	13,880	9,714	7,921	79,243	69
1988	49,700	14,000	10,059	8,765	82,523	68
1989	50,548	14,119	9,839	9,777	84,284	68
1990	51,352	13,745	8,686	9,755	83,539	66
1991	51,036	13,651	9,049	10,380	84,117	65
1992	55,241	13,482	10,768	10,170	89,661	68
1993	49,790	13,314	9,929	11,973	85,005	66

Sources:

Consumption -- Energy Information Administration

Emission Factors -- US Department of Energy

Greenhouse gas emissions per unit of energy consumed peaked in 1977 following the start up of the Centralia coal-fired electricity generation plant and the corresponding jump in coal consumption. The indicator declined through the early 1980s when the hydroelectric share of electricity generation peaked.

What Does It Mean?

The trends in greenhouse gas emissions from energy consumption illustrate that Washington continued to be dependent on fossil fuels throughout the 1970 to 1993 period. The emissions per unit of energy consumption did not decline. Almost all the growth in primary energy consumption came from fossil fuels -- petroleum, coal, wood, and natural gas. The share of consumption from renewable energy sources like hydroelectricity that produce no greenhouse gas emissions declined. This resulted in growth of greenhouse gas emissions that exceeded growth in energy consumption.

About the Data

Greenhouse gas emissions are estimated using emission factors for carbon dioxide from the US Department of Energy. The emission factors for each fuel are multiplied by the amount of primary fuel consumed to get the greenhouse emissions resulting from the consumption of that fuel. Energy consumption data are from the Energy Information Administration. Primary energy consumption includes wood consumption which is based on Washington State Energy Office estimates.

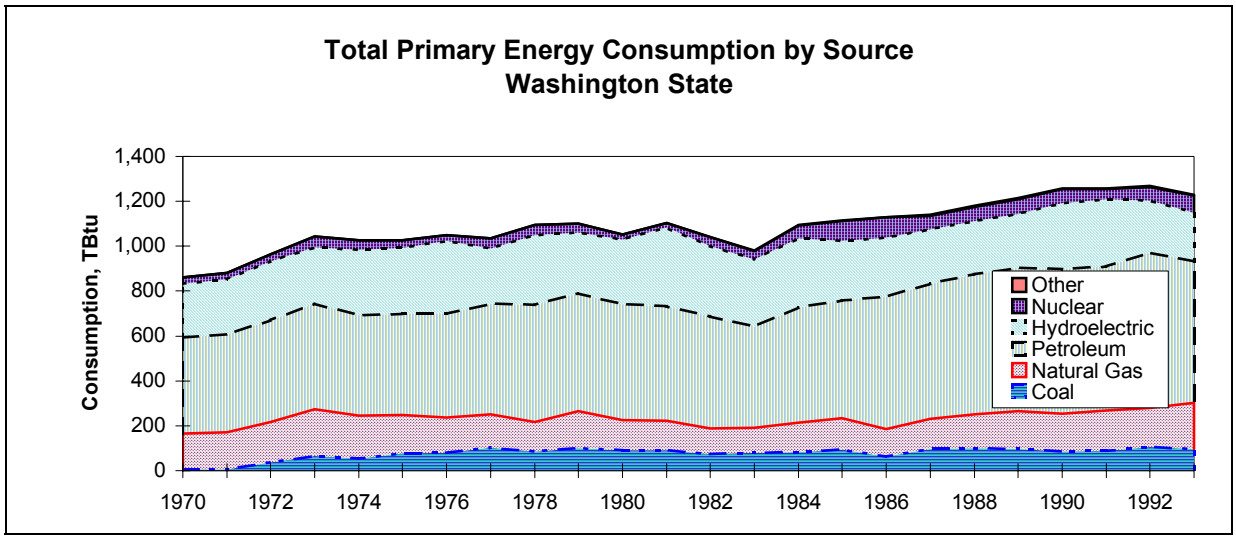
APPENDIX A: TRENDS IN TOTAL USE

Total Primary Energy Consumption By Energy Source

Total End-Use Energy Consumption By Sector

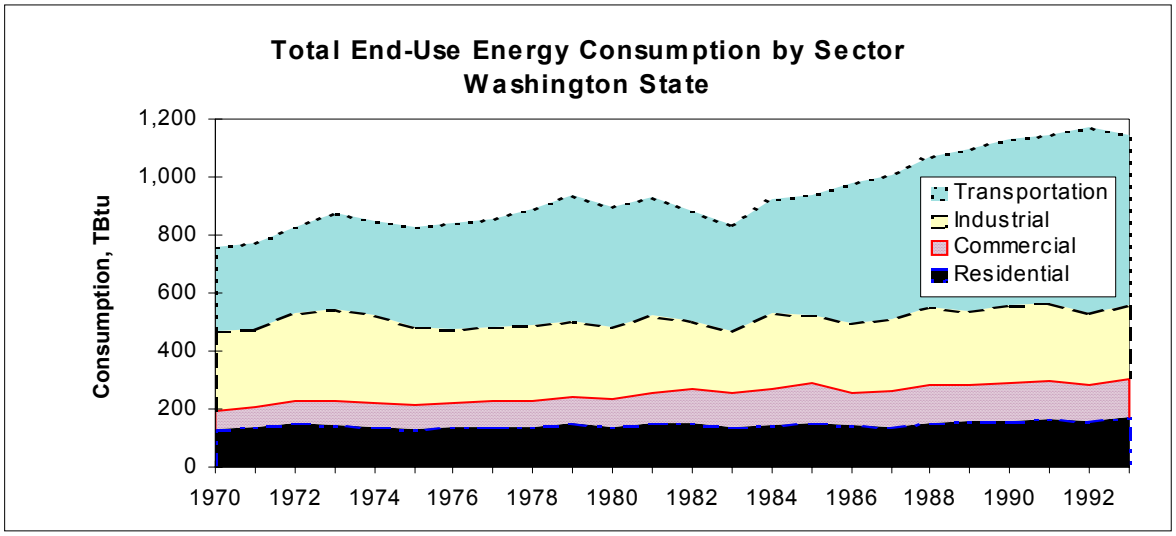
Total End-Use Energy Expenditures By Sector

Average End-Use Prices By Sector



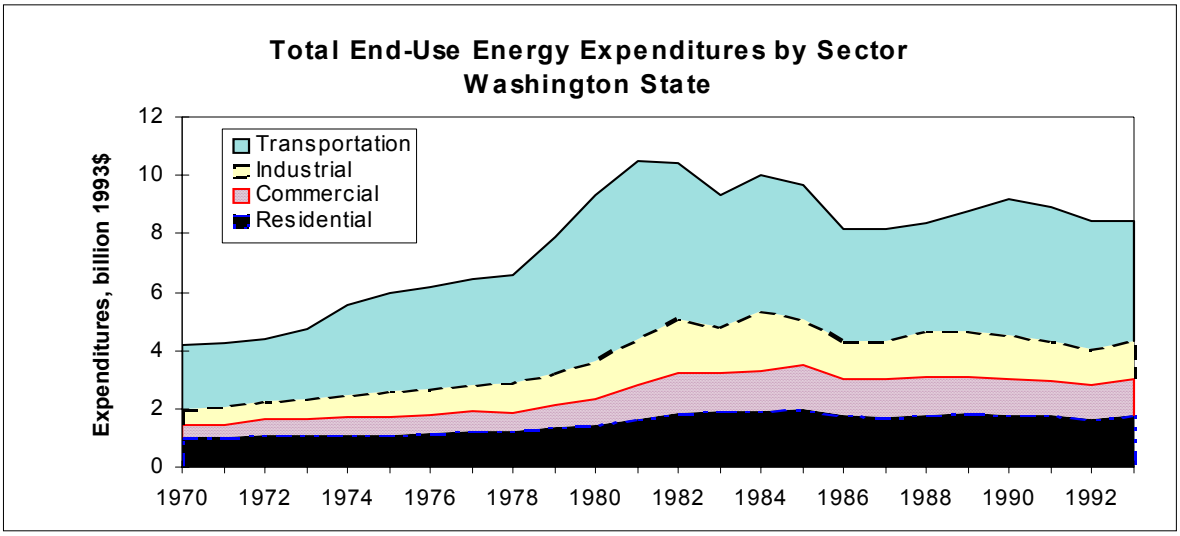
	Coal	Natural Gas	Petroleum	Hydro-electric	Nuclear	Other	Total Consumption
Year	TBtu	TBtu	TBtu	TBtu	TBtu	TBtu	TBtu
1970	6	158	429	239	29	0	862
1971	6	165	436	245	28	0	880
1972	37	180	454	262	32	0	964
1973	65	208	471	252	48	0	1,044
1974	54	191	448	290	43	0	1,026
1975	76	171	452	292	36	0	1,028
1976	81	155	462	324	27	0	1,049
1977	102	149	493	244	46	0	1,036
1978	85	133	519	312	45	0	1,095
1979	99	166	526	271	39	0	1,101
1980	91	135	516	287	22	0	1,051
1981	91	131	511	349	23	0	1,105
1982	74	114	498	313	40	0	1,040
1983	80	112	449	300	38	0	980
1984	82	132	514	307	58	1	1,094
1985	94	140	525	266	87	3	1,114
1986	63	122	591	261	91	2	1,130
1987	96	136	602	242	60	4	1,139
1988	99	151	625	236	64	4	1,179
1989	97	168	638	241	66	4	1,214
1990	86	168	646	293	61	3	1,257
1991	89	178	642	299	45	3	1,257
1992	106	175	692	231	61	4	1,268
1993	98	206	628	218	76	4	1,230

Sources:
Consumption -- Energy Information Administration



	Residential Consumption	Commercial Consumption	Industrial Consumption	Transportation Consumption	Total Consumption
Year	TBtu	TBtu	TBtu	TBtu	TBtu
1970	132	61	274	289	756
1971	138	66	272	296	772
1972	148	76	305	300	830
1973	144	87	315	327	873
1974	136	84	301	327	848
1975	132	82	266	349	830
1976	135	84	256	365	840
1977	139	86	259	375	859
1978	140	85	264	403	892
1979	148	93	260	434	936
1980	139	94	252	413	898
1981	149	105	272	402	929
1982	153	117	235	377	882
1983	141	115	213	363	832
1984	143	123	264	392	922
1985	152	138	234	412	935
1986	142	116	241	480	979
1987	139	122	251	496	1,008
1988	149	133	271	518	1,072
1989	157	127	255	560	1,099
1990	160	129	272	570	1,131
1991	168	131	267	577	1,143
1992	156	124	252	639	1,171
1993	174	131	253	586	1,143

Sources:
Consumption -- Energy Information Administration

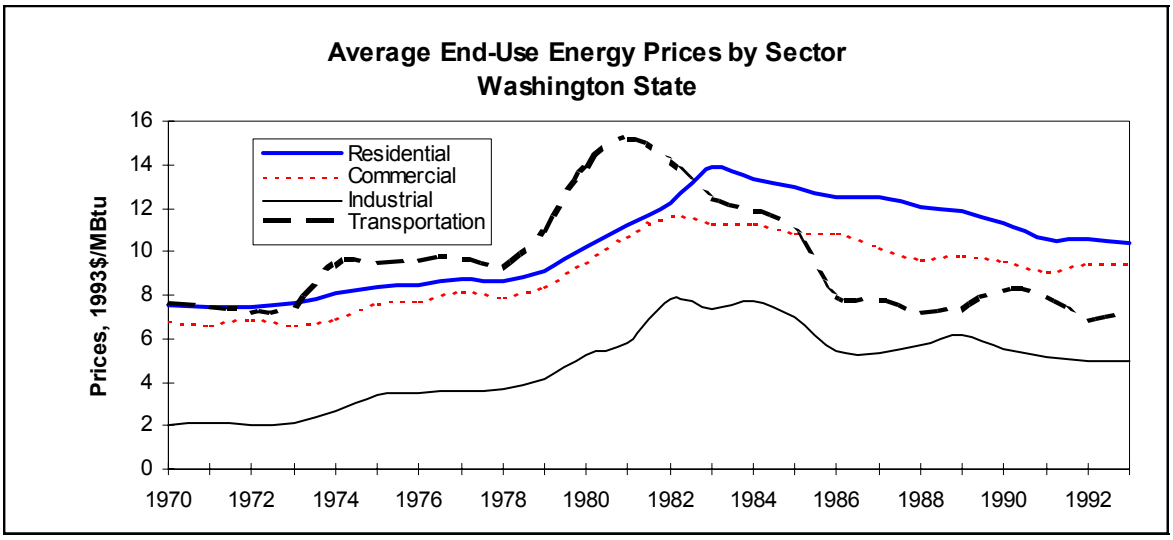


	Residential Energy Expenditures	Commercial Energy Expenditures	Industrial Energy Expenditures	Transportation Energy Expenditures	Total Energy Expenditures
Year	billion 1993$	billion 1993$	billion 1993$	billion 1993$	billion 1993$
1970	1.00	0.42	0.56	2.21	4.19
1971	1.03	0.43	0.57	2.20	4.23
1972	1.10	0.53	0.63	2.15	4.40
1973	1.10	0.58	0.66	2.40	4.73
1974	1.10	0.58	0.81	3.07	5.56
1975	1.11	0.63	0.89	3.30	5.94
1976	1.15	0.65	0.89	3.48	6.16
1977	1.21	0.70	0.93	3.63	6.47
1978	1.21	0.67	0.97	3.75	6.60
1979	1.35	0.78	1.09	4.70	7.92
1980	1.41	0.89	1.33	5.68	9.32
1981	1.68	1.12	1.59	6.11	10.49
1982	1.87	1.37	1.83	5.36	10.43
1983	1.95	1.30	1.58	4.51	9.33
1984	1.92	1.39	2.04	4.66	10.00
1985	1.98	1.49	1.64	4.56	9.66
1986	1.77	1.26	1.31	3.81	8.15
1987	1.74	1.25	1.34	3.84	8.16
1988	1.80	1.29	1.55	3.73	8.37
1989	1.85	1.26	1.57	4.12	8.80
1990	1.81	1.23	1.50	4.66	9.20
1991	1.78	1.19	1.37	4.56	8.89
1992	1.65	1.17	1.25	4.34	8.41
1993	1.81	1.23	1.25	4.14	8.43

Sources:

Expenditures -- Energy Information Administration

Price Deflator -- OFM, Forecasting Division, Washington Economic and Revenue Forecast



Year	Residential Energy Prices 1993$/MBtu	Commercial Energy Prices 1993$/MBtu	Industrial Energy Prices 1993$/MBtu	Transportation Energy Prices 1993$/MBtu	Average Energy Prices 1993$/MBtu
1970	7.56	6.77	2.04	7.67	5.54
1971	7.43	6.63	2.10	7.43	5.48
1972	7.42	6.89	2.05	7.15	5.30
1973	7.61	6.66	2.10	7.35	5.42
1974	8.08	6.93	2.68	9.40	6.56
1975	8.41	7.64	3.36	9.46	7.16
1976	8.49	7.73	3.46	9.52	7.33
1977	8.71	8.15	3.59	9.68	7.54
1978	8.61	7.91	3.68	9.30	7.40
1979	9.11	8.35	4.17	10.83	8.46
1980	10.19	9.51	5.28	13.76	10.38
1981	11.24	10.65	5.83	15.18	11.30
1982	12.20	11.68	7.82	14.20	11.82
1983	13.85	11.32	7.38	12.40	11.21
1984	13.38	11.33	7.73	11.87	10.85
1985	13.00	10.84	7.01	11.07	10.33
1986	12.50	10.87	5.44	7.93	8.32
1987	12.48	10.21	5.32	7.74	8.09
1988	12.06	9.67	5.73	7.20	7.81
1989	11.84	9.86	6.15	7.36	8.00
1990	11.29	9.53	5.52	8.18	8.13
1991	10.57	9.08	5.14	7.90	7.78
1992	10.55	9.46	4.94	6.79	7.18
1993	10.41	9.45	4.94	7.07	7.38

Sources:

Consumption and Expenditures -- Energy Information Administration

Price Deflator -- OFM, Forecasting Division, Washington Economic and Revenue Forecast

APPENDIX B:
ENERGY USE TRENDS BY ENERGY RESOURCE

Natural Gas

Petroleum

Electricity

Coal

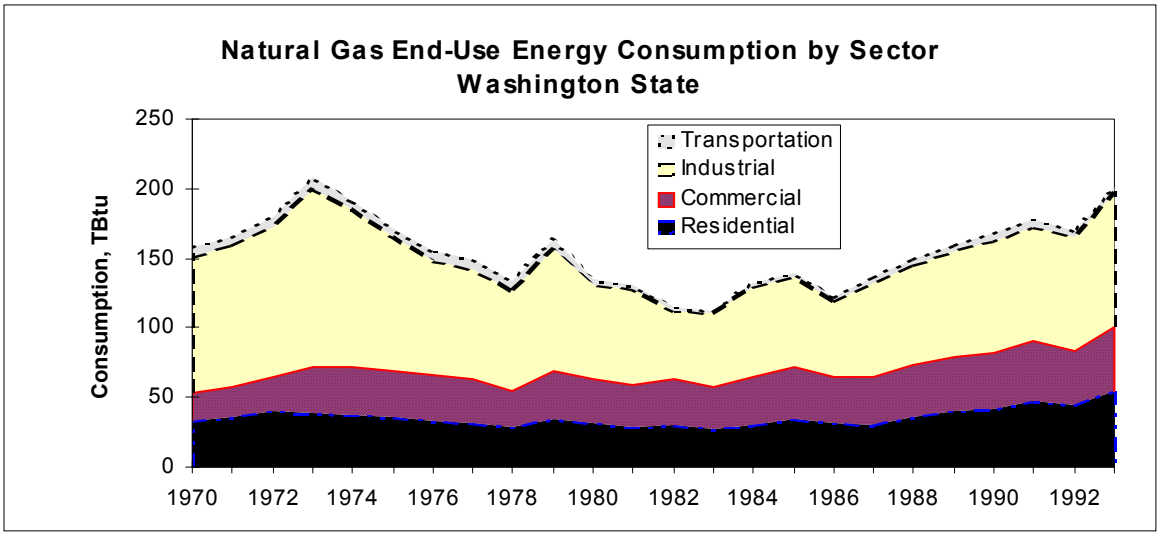
Wood

Natural Gas

Consumption By Sector

Expenditures By Sector

Prices By Sector



	Residential Consumption	Commercial Consumption	Industrial Consumption	Transportation Consumption[1]	Total Consumption
Year	TBtu	TBtu	TBtu	TBtu	TBtu
1970	34	20	98	7	158
1971	36	22	101	6	165
1972	41	25	107	8	180
1973	38	34	128	8	208
1974	37	35	114	6	191
1975	36	33	96	6	171
1976	34	33	82	6	155
1977	32	31	79	6	149
1978	29	27	71	7	133
1979	34	35	87	8	164
1980	31	32	67	4	134
1981	28	30	70	2	131
1982	31	32	50	2	114
1983	27	30	53	2	112
1984	31	34	66	2	132
1985	34	37	66	3	140
1986	31	33	56	2	122
1987	31	33	68	4	136
1988	36	38	71	4	149
1989	40	40	76	4	159
1990	42	40	81	5	167
1991	48	43	82	5	178
1992	44	39	82	3	169
1993	55	45	96	4	201

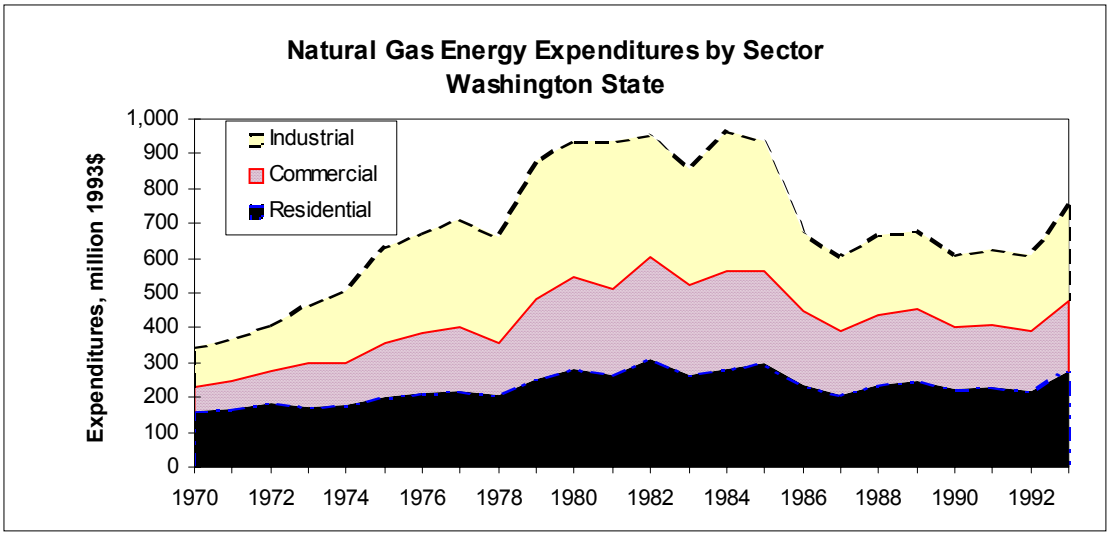
Notes:

Transportation includes natural gas used in gas pipeline transport.

Natural gas consumption for other forms of transportation is not seperated from the other sectors.

Sources:

Consumption -- Energy Information Administration



	Residential Energy Expenditures	Commercial Energy Expenditures	Industrial Energy Expenditures	Total Energy Expenditures
Year	million 1993$	million 1993$	million 1993$	million 1993$
1970	160	73	114	346
1971	165	79	122	367
1972	185	88	133	406
1973	175	125	168	468
1974	177	124	206	508
1975	203	151	276	630
1976	214	173	283	670
1977	219	184	310	713
1978	204	154	302	661
1979	255	227	398	879
1980	281	264	392	937
1981	264	250	420	934
1982	309	293	351	953
1983	264	257	337	858
1984	283	279	401	963
1985	297	264	375	936
1986	237	214	224	675
1987	205	185	214	604
1988	234	205	225	665
1989	245	209	225	679
1990	224	177	211	611
1991	229	180	215	624
1992	221	168	220	609
1993	279	198	275	752

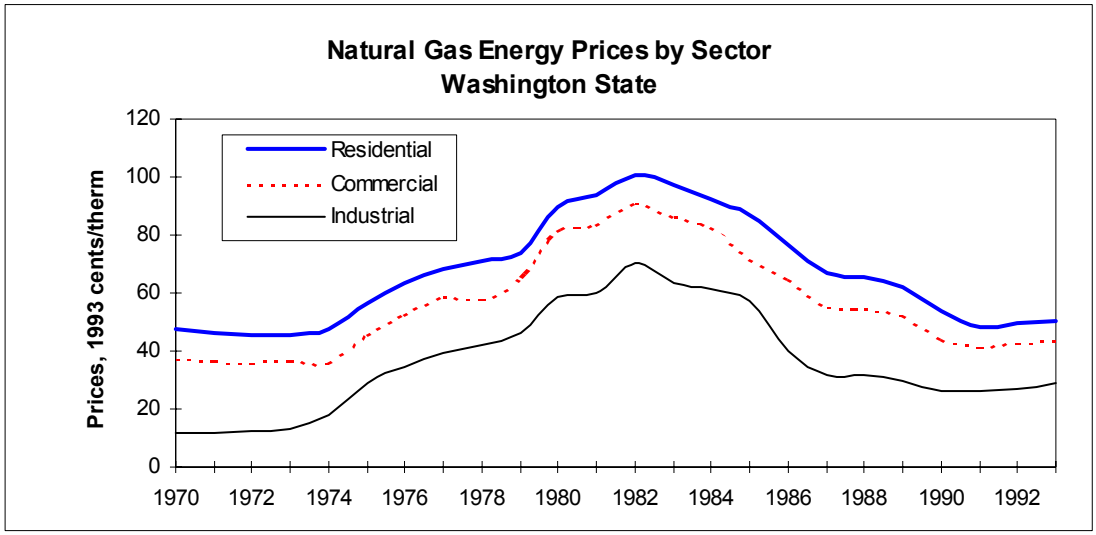
Notes:

Natural gas expenditures for transportation are not seperated from the other sectors.

Sources:

Expenditures -- Energy Information Administration

Price Deflator -- OFM, Forecasting Division, Washington Economic and Revenue Forecast



	Residential Energy Prices	Commercial Energy Prices	Industrial Energy Prices	Average Energy Prices
Year	1993 cents/ therm	1993 cents/ therm	1993 cents/ therm	1993 cents/ therm
1970	47.4	37.3	11.6	21.9
1971	46.2	36.4	12.0	22.2
1972	45.5	36.0	12.4	22.6
1973	45.7	36.7	13.1	22.5
1974	47.6	35.8	18.2	26.5
1975	56.7	45.4	28.7	36.8
1976	63.5	52.6	34.5	43.3
1977	68.6	58.7	39.1	47.8
1978	71.1	58.1	42.3	49.6
1979	74.0	64.9	45.9	53.7
1980	89.8	81.7	58.5	69.7
1981	93.6	83.1	60.0	71.5
1982	100.8	91.1	70.7	83.4
1983	97.2	85.9	63.6	76.8
1984	92.8	82.5	61.1	73.0
1985	86.6	71.5	57.1	66.9
1986	76.2	64.9	40.2	55.4
1987	66.6	55.3	31.6	44.4
1988	65.3	54.5	31.7	44.7
1989	61.8	52.7	29.8	42.6
1990	53.8	44.4	26.1	36.5
1991	48.1	41.7	26.2	35.0
1992	49.8	43.0	26.7	36.0
1993	50.5	43.7	28.8	37.5

Notes:

Natural gas prices for transportation are not seperated from the other sectors.

Sources:

Consumption and Expenditures -- Energy Information Administration

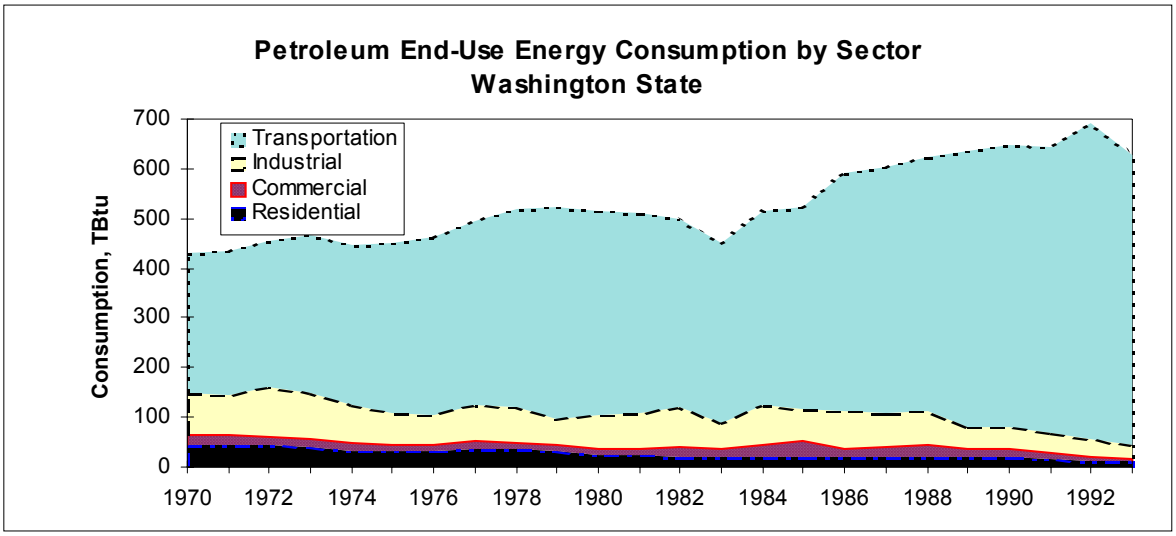
Price Deflator -- OFM, Forecasting Division, Washington Economic and Revenue

Petroleum

Consumption By Sector

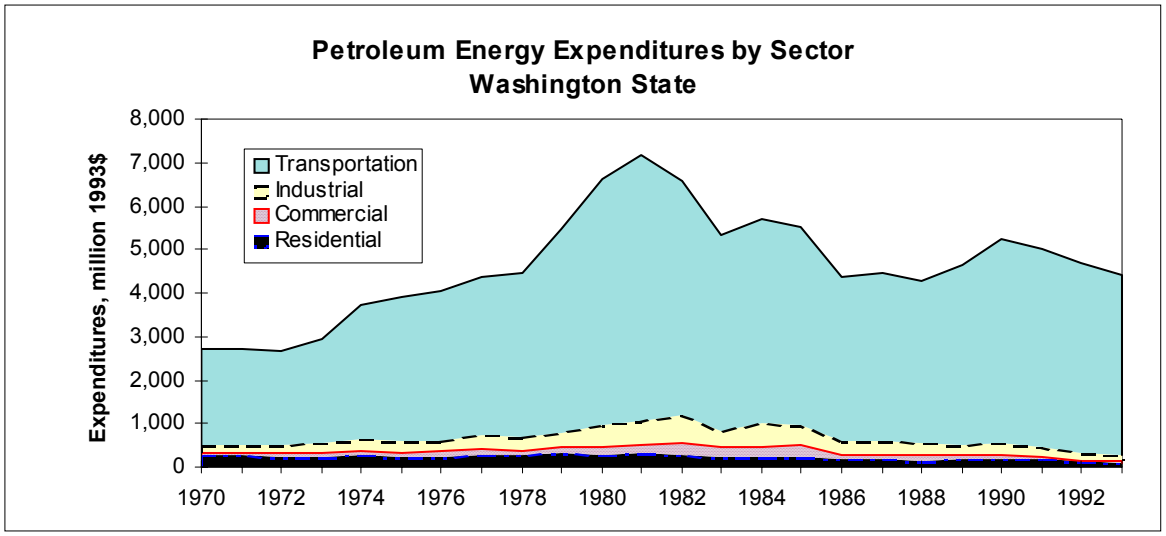
Expenditures By Sector

Prices By Sector



	Residential Consumption	Commercial Consumption	Industrial Consumption	Transportation Consumption	Total Consumption
Year	TBtu	TBtu	TBtu	TBtu	TBtu
1970	46	18	83	282	429
1971	46	18	82	289	436
1972	43	18	99	293	453
1973	40	17	92	319	468
1974	32	15	79	321	447
1975	31	13	65	343	452
1976	32	13	58	359	462
1977	36	15	74	369	493
1978	35	15	73	397	519
1979	31	12	53	426	522
1980	23	12	71	409	514
1981	23	12	76	400	510
1982	22	20	80	375	498
1983	19	19	49	362	449
1984	20	24	79	390	514
1985	21	33	63	408	525
1986	20	17	75	478	591
1987	20	21	69	492	602
1988	20	24	68	514	625
1989	19	16	47	556	637
1990	20	14	47	565	646
1991	18	12	41	572	642
1992	14	6	35	636	692
1993	12	5	28	581	627

Sources:
Consumption -- Energy Information Administration

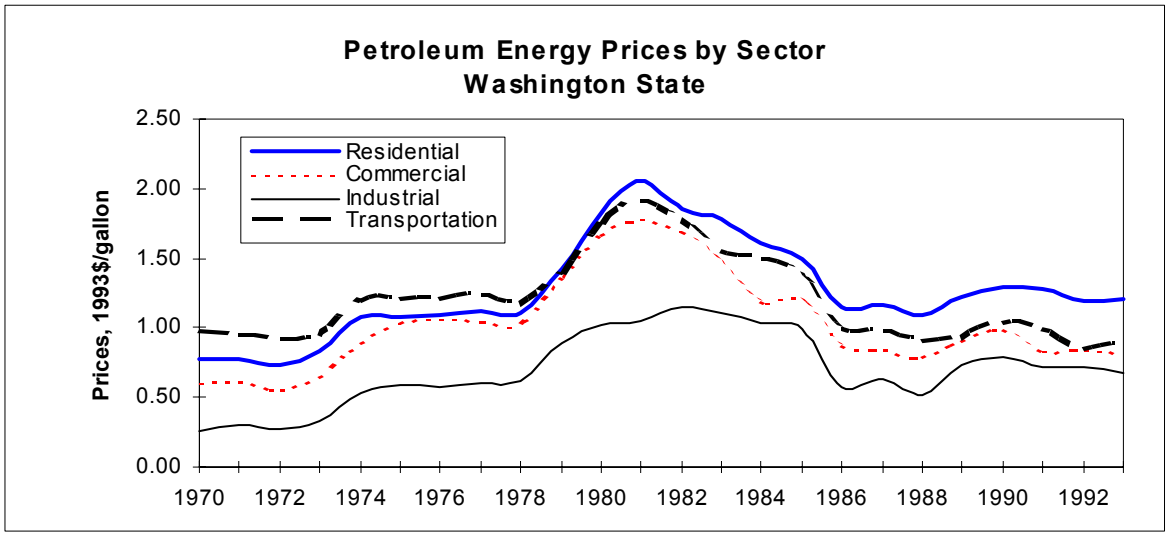


	Residential Energy Expenditures	Commercial Energy Expenditures	Industrial Energy Expenditures	Transportation Energy Expenditures	Total Energy Expenditures
Year	million 1993$	million 1993$	million 1993$	million 1993$	million 1993$
1970	257	80	152	2,214	2,703
1971	257	81	179	2,199	2,716
1972	227	75	199	2,147	2,649
1973	237	81	215	2,399	2,932
1974	253	97	307	3,070	3,727
1975	237	100	277	3,304	3,918
1976	251	102	239	3,475	4,067
1977	287	111	321	3,633	4,352
1978	279	109	324	3,750	4,462
1979	319	119	338	4,701	5,478
1980	297	143	517	5,684	6,641
1981	340	154	574	6,109	7,177
1982	292	250	669	5,355	6,566
1983	243	206	393	4,505	5,346
1984	230	211	592	4,655	5,688
1985	221	287	450	4,555	5,513
1986	164	109	310	3,806	4,389
1987	171	126	317	3,835	4,449
1988	157	133	254	3,729	4,273
1989	164	104	246	4,119	4,633
1990	188	104	267	4,660	5,220
1991	165	71	209	4,558	5,003
1992	121	39	182	4,343	4,684
1993	108	31	137	4,141	4,417

Sources:

Expenditures -- Energy Information Administration

Price Deflator -- OFM, Forecasting Division, Washington Economic and Revenue Forecast



Year	Residential Energy Prices 1993$/gallon[1]	Commercial Energy Prices 1993$/gallon[1]	Industrial Energy Prices 1993$/gallon[1]	Transportation Energy Prices 1993$/gallon[2]	Average Energy Prices 1993$/gallon[2]
1970	0.78	0.60	0.25	0.98	0.79
1971	0.78	0.61	0.30	0.95	0.78
1972	0.74	0.57	0.28	0.92	0.73
1973	0.83	0.65	0.32	0.94	0.78
1974	1.08	0.90	0.54	1.20	1.04
1975	1.07	1.03	0.60	1.20	1.08
1976	1.09	1.06	0.57	1.21	1.10
1977	1.12	1.05	0.60	1.23	1.10
1978	1.10	1.03	0.62	1.18	1.07
1979	1.42	1.35	0.89	1.38	1.31
1980	1.82	1.67	1.02	1.74	1.61
1981	2.05	1.79	1.05	1.91	1.76
1982	1.86	1.70	1.16	1.78	1.65
1983	1.78	1.48	1.11	1.56	1.49
1984	1.61	1.19	1.03	1.49	1.38
1985	1.49	1.21	0.99	1.39	1.31
1986	1.15	0.88	0.57	1.00	0.93
1987	1.17	0.85	0.63	0.98	0.92
1988	1.09	0.79	0.52	0.91	0.85
1989	1.23	0.91	0.73	0.93	0.91
1990	1.29	1.00	0.80	1.03	1.01
1991	1.28	0.84	0.72	1.00	0.97
1992	1.20	0.84	0.72	0.85	0.85
1993	1.21	0.82	0.67	0.89	0.88

Notes:

1. Distillate fuel equivalent
2. Gasoline equivalent

Sources:

Consumption and Expenditures -- Energy information Administration

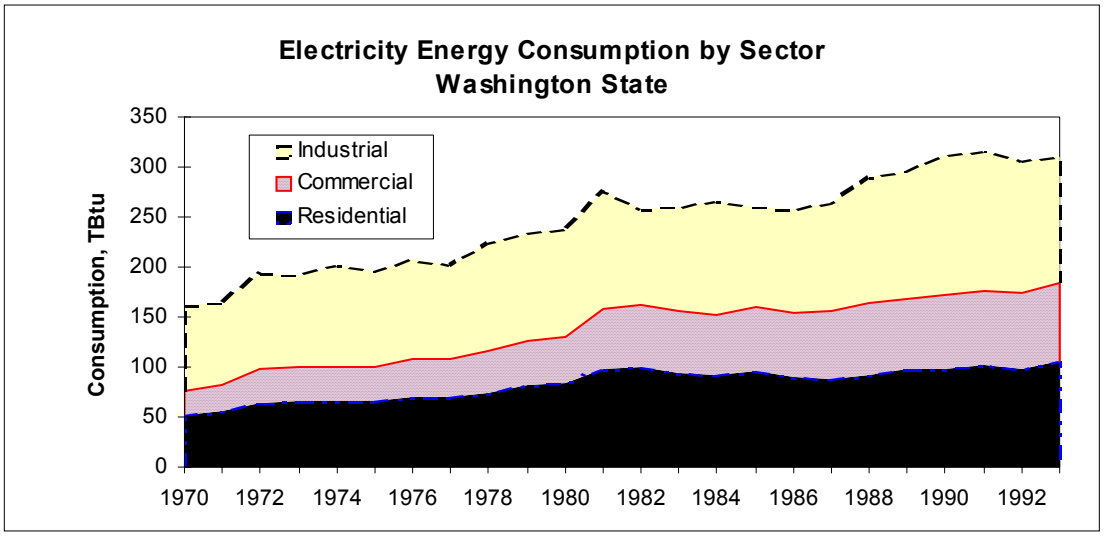
Price Deflator -- OFM, Forecasting Division, Washington Economic and Revenue Forecast

Electricity

Consumption By Sector

Expenditures By Sector

Prices By Sector



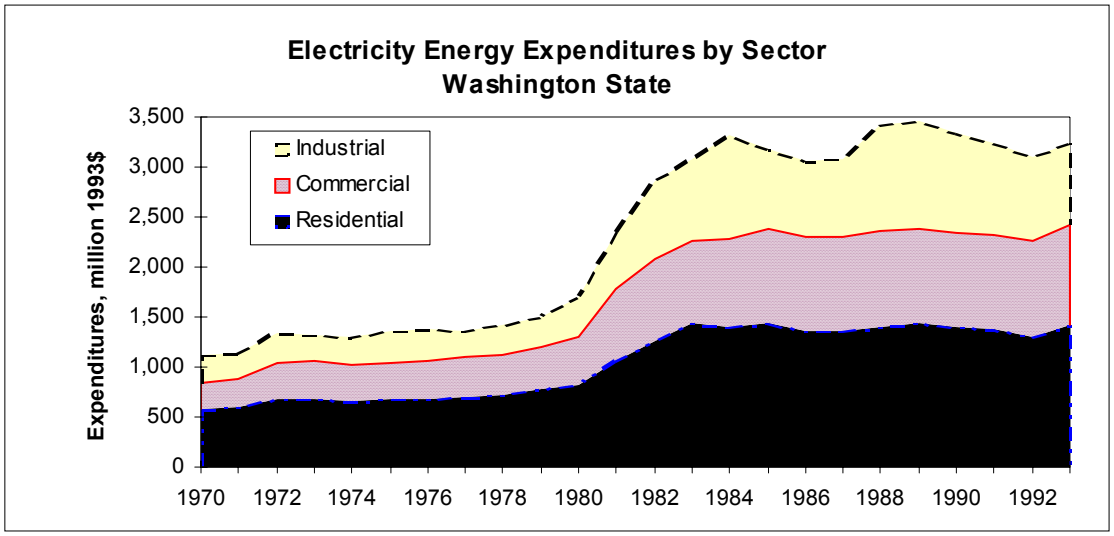
	Residential Consumption	Commercial Consumption	Industrial Consumption	Total Consumption
Year	TBtu	TBtu	TBtu	TBtu
1970	52	23	88	163
1971	56	25	84	165
1972	65	33	96	194
1973	66	35	92	193
1974	66	34	102	203
1975	66	35	94	195
1976	69	38	102	209
1977	70	38	93	201
1978	75	41	107	223
1979	82	44	108	234
1980	83	47	107	238
1981	97	61	119	277
1982	99	62	97	258
1983	93	62	106	261
1984	91	61	114	267
1985	95	65	101	261
1986	90	64	103	258
1987	88	67	108	263
1988	93	71	126	290
1989	98	70	128	296
1990	98	73	139	311
1991	102	75	140	317
1992	97	77	131	305
1993	106	78	125	309

Notes:

Electricity consumption for transportation is not seperated from the other sectors.

Sources:

Consumption -- Energy Information Administration



	Residential Energy Expenditures	Commercial Energy Expenditures	Industrial Energy Expenditures	Total Energy Expenditures
Year	million 1993$	million 1993$	million 1993$	million 1993$
1970	582	262	284	1,129
1971	604	273	262	1,139
1972	686	362	290	1,338
1973	683	372	272	1,327
1974	667	363	280	1,310
1975	671	378	313	1,362
1976	681	376	323	1,380
1977	702	398	262	1,362
1978	715	401	306	1,422
1979	770	426	307	1,503
1980	825	476	394	1,695
1981	1,068	704	560	2,332
1982	1,259	813	781	2,853
1983	1,435	824	826	3,086
1984	1,394	892	1,032	3,318
1985	1,449	933	799	3,181
1986	1,370	930	759	3,058
1987	1,363	932	787	3,082
1988	1,409	948	1,056	3,412
1989	1,442	939	1,086	3,467
1990	1,398	943	1,009	3,350
1991	1,380	934	934	3,249
1992	1,303	960	834	3,098
1993	1,422	1,000	826	3,248

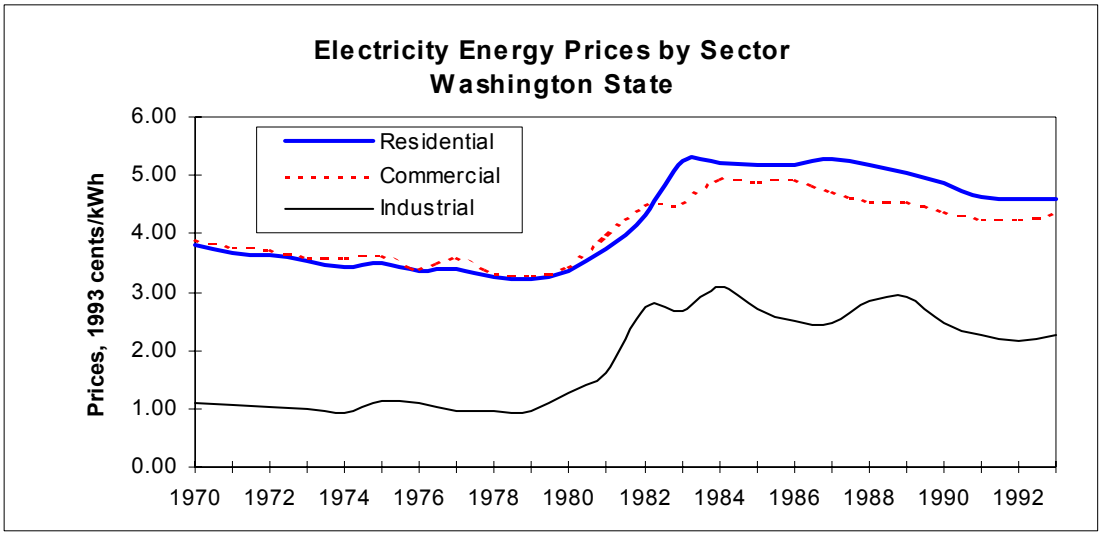
Notes:

Electricity expenditures for transportation are not seperated from the other sectors.

Sources:

Expenditures -- Energy Information Administration

Price Deflator -- OFM, Forecasting Division, Washington Economic and Revenue Forecast



	Residential Energy Prices	Commercial Energy Prices	Industrial Energy Prices	Average Energy Prices
Year	1993 cents/kWh	1993 cents/kWh	1993 cents/kWh	1993 cents/kWh
1970	3.79	3.90	1.11	2.36
1971	3.66	3.77	1.07	2.36
1972	3.62	3.75	1.03	2.36
1973	3.55	3.61	1.01	2.35
1974	3.44	3.61	0.94	2.21
1975	3.49	3.64	1.14	2.38
1976	3.35	3.39	1.08	2.26
1977	3.40	3.60	0.96	2.31
1978	3.26	3.32	0.97	2.17
1979	3.21	3.29	0.97	2.19
1980	3.37	3.44	1.25	2.43
1981	3.75	3.95	1.61	2.87
1982	4.32	4.48	2.76	4.03
1983	5.26	4.52	2.67	4.04
1984	5.22	4.95	3.08	4.24
1985	5.19	4.92	2.70	4.16
1986	5.17	4.94	2.51	4.05
1987	5.29	4.73	2.48	3.99
1988	5.18	4.58	2.85	3.99
1989	5.03	4.55	2.90	4.00
1990	4.85	4.38	2.47	3.67
1991	4.62	4.25	2.28	3.50
1992	4.58	4.26	2.17	3.46
1993	4.60	4.36	2.25	3.59

Notes:

Electricity prices for transportation are not seperated from the other sectors.

Sources:

Consumption and Expenditures -- Energy Information Administration

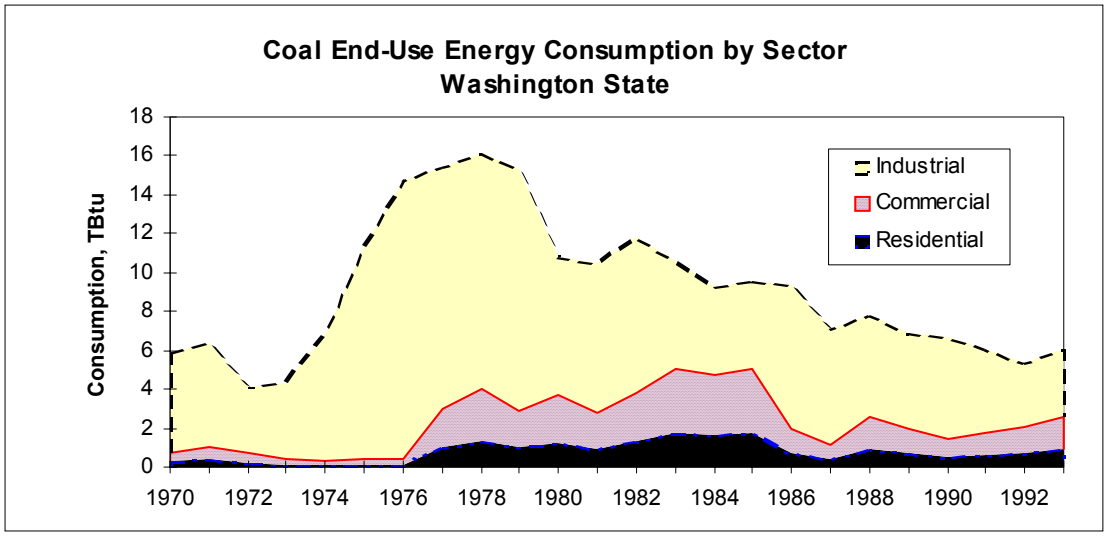
Price Deflator -- OFM, Forecasting Division, Washington Economic and Revenue Forecast-

Coal

Consumption By Sector

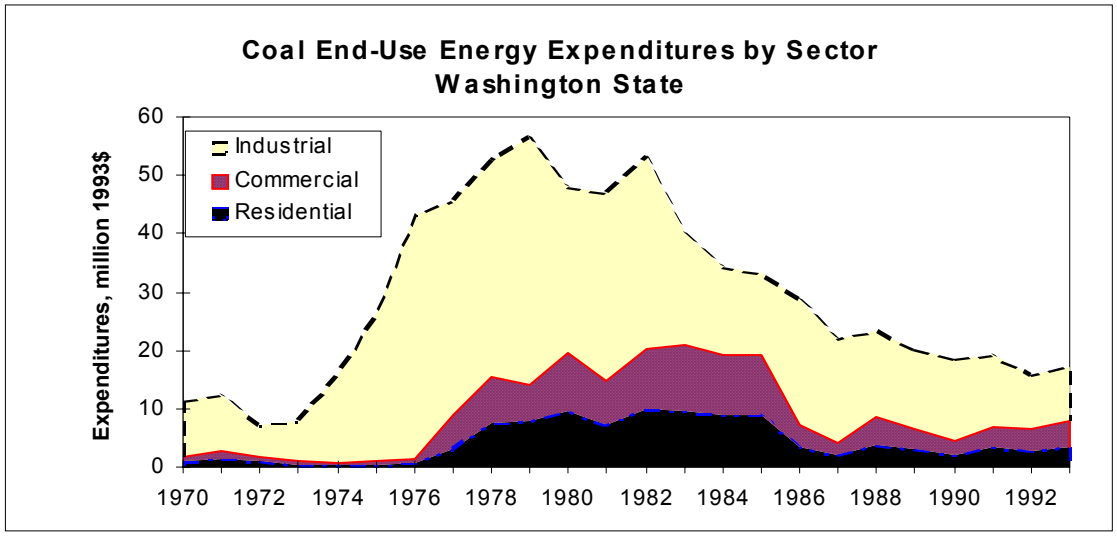
Expenditures By sector

Prices By Sector



Year	Residential Consumption TBtu	Commercial Consumption TBtu	Industrial Consumption TBtu	Total Consumption TBtu
1970	0.3	0.5	5.1	5.9
1971	0.4	0.7	5.3	6.4
1972	0.2	0.5	3.4	4.1
1973	0.1	0.3	3.9	4.3
1974	0.1	0.2	6.5	6.8
1975	0.1	0.3	10.9	11.3
1976	0.2	0.3	14.2	14.7
1977	1.0	1.9	12.4	15.4
1978	1.4	2.6	12.2	16.1
1979	1.0	1.8	12.5	15.3
1980	1.3	2.4	7.1	10.8
1981	1.0	1.8	7.7	10.4
1982	1.3	2.5	7.9	11.8
1983	1.8	3.3	5.6	10.6
1984	1.7	3.1	4.5	9.3
1985	1.8	3.3	4.5	9.6
1986	0.7	1.3	7.4	9.3
1987	0.4	0.8	5.9	7.1
1988	0.9	1.7	5.3	7.8
1989	0.7	1.3	4.9	6.9
1990	0.5	0.9	5.2	6.6
1991	0.6	1.2	4.3	6.1
1992	0.7	1.3	3.4	5.4
1993	0.9	1.7	3.5	6.1

Sources:
Consumption -- Energy Information Administration

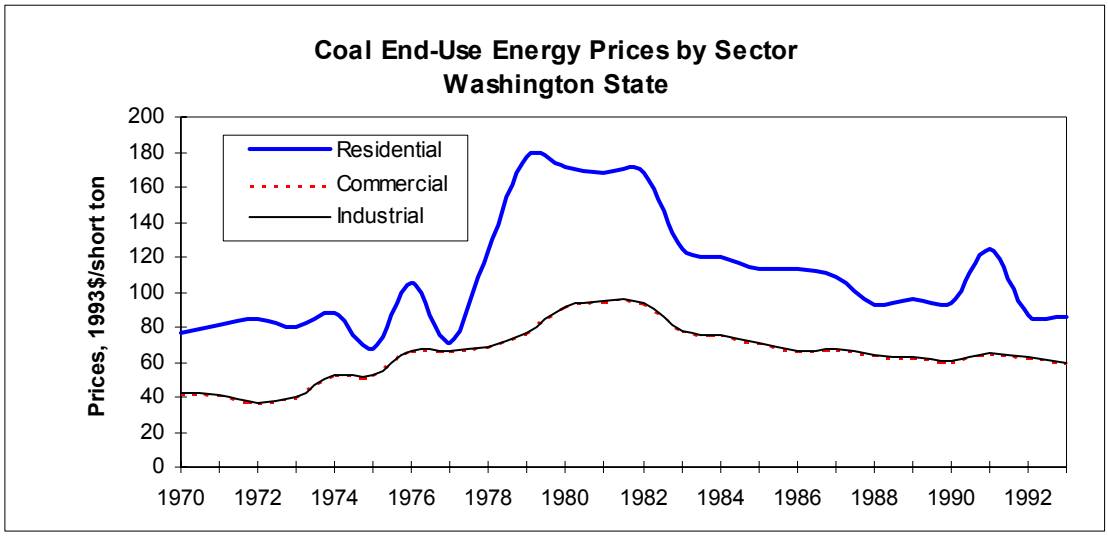


	Residential Energy Expenditures	Commercial Energy Expenditures	Industrial Energy Expenditures	Total Energy Expenditures
Year	million 1993$	million 1993$	million 1993$	million 1993$
1970	0.9	0.9	9.5	11
1971	1.3	1.3	9.8	12
1972	0.9	0.7	5.6	7
1973	0.5	0.4	6.9	8
1974	0.4	0.4	15.1	16
1975	0.4	0.6	25.5	26
1976	0.7	0.8	41.8	43
1977	3.3	5.7	36.5	45
1978	7.6	7.8	37.1	53
1979	7.8	6.3	42.6	57
1980	9.7	9.7	28.8	48
1981	7.2	7.6	32.2	47
1982	10.0	10.3	32.8	53
1983	9.7	11.2	19.2	40
1984	8.9	10.4	15.1	34
1985	8.9	10.3	14.1	33
1986	3.4	3.7	21.7	29
1987	2.0	2.3	17.6	22
1988	3.7	4.7	15.0	23
1989	3.0	3.6	13.7	20
1990	2.1	2.5	14.1	19
1991	3.5	3.4	12.3	19
1992	2.7	3.7	9.4	16
1993	3.4	4.4	9.2	17

Sources:

Expenditures -- Energy Information Administration

Price Deflator -- OFM, Forecasting Division, Washington Economic and Revenue Forecast-



	Residential Energy Prices	Commercial Energy Prices	Industrial Energy Prices	Average Energy Prices
Year	1993$/short ton	1993$/short ton	1993$/short ton	1993$/short ton
1970	76.24	42.10	42.10	43.66
1971	80.94	41.63	41.63	43.91
1972	84.88	36.56	36.56	39.44
1973	80.53	39.65	39.65	40.95
1974	88.17	52.64	52.64	53.17
1975	66.98	52.82	52.82	52.99
1976	105.38	66.31	66.31	66.71
1977	70.65	66.53	66.53	66.81
1978	123.22	68.81	68.81	73.49
1979	177.64	77.04	77.04	83.56
1980	171.23	91.68	91.68	101.17
1981	168.21	94.93	94.93	101.75
1982	168.05	93.18	93.18	101.73
1983	124.82	77.86	77.86	85.63
1984	120.35	75.46	75.46	83.53
1985	113.31	70.83	70.83	78.71
1986	113.22	66.33	66.33	69.78
1987	108.03	67.61	67.61	69.96
1988	92.67	64.31	64.31	67.56
1989	96.05	62.61	62.61	65.97
1990	94.21	61.13	61.13	63.64
1991	124.55	65.25	65.25	71.39
1992	87.22	63.12	63.12	66.29
1993	85.30	59.39	59.39	63.22

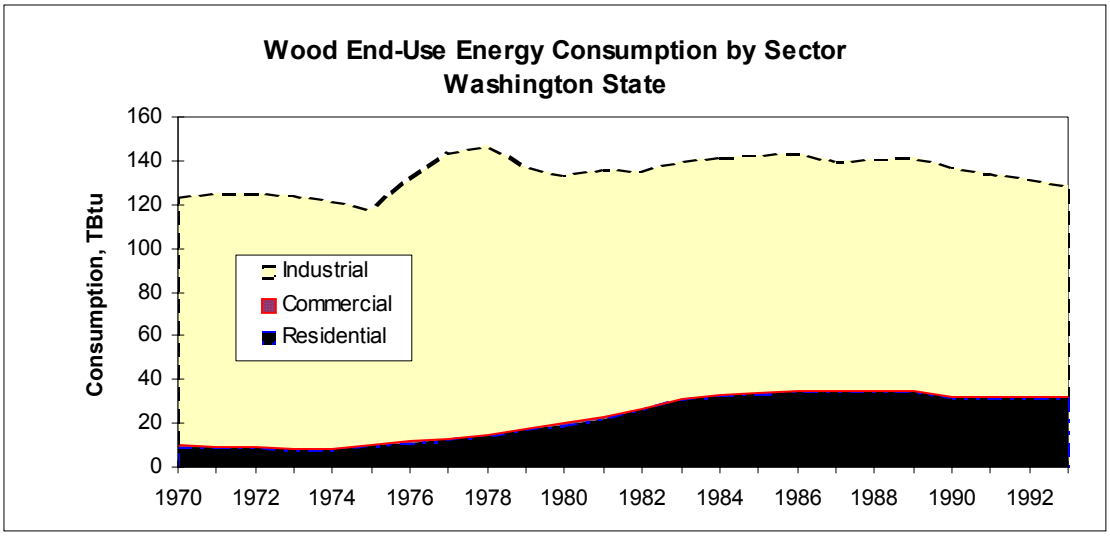
Sources:

Consumption and Expenditures -- Energy Information Administration

Price Deflator -- OFM, Forecasting Division, Washington Economic and Revenue Forecast-

Wood

Consumption By Sector



Year	Residential Consumption TBtu	Commercial Consumption TBtu	Industrial Consumption TBtu[1]	Total Consumption TBtu
1970	10	0	114	123
1971	9	0	116	125
1972	9	0	116	125
1973	8	0	116	124
1974	8	0	113	122
1975	10	0	108	118
1976	11	0	120	131
1977	13	0	130	144
1978	14	0	133	148
1979	17	0	120	137
1980	19	0	114	133
1981	22	0	113	136
1982	27	0	109	136
1983	31	0	109	140
1984	33	0	109	142
1985	34	0	109	143
1986	35	0	109	143
1987	35	0	105	140
1988	35	0	106	141
1989	35	0	107	142
1990	32	0	105	137
1991	32	0	103	135
1992	32	0	100	132
1993	32	0	97	129

Note:

1. Industrial wood consumption includes wood pulp or black liquor

Sources:

Consumption -- Washington State Energy Office

APPENDIX C: ECONOMIC AND DEMOGRAPHIC DATA

Year	Washington GSP (million 1993$)	United States GDP, (Billion 1993$)	Washington Population	United States Population (1000)
1970	*65,550*	3,549	3,413,300	203,984
1971	*67,420*	3,651	3,436,300	206,827
1972	*70,869*	3,837	3,430,300	209,284
1973	*74,553*	4,037	3,444,300	211,357
1974	*74,085*	4,011	3,508,700	213,342
1975	*73,483*	3,979	3,567,900	215,465
1976	*77,112*	4,175	3,634,900	217,563
1977	80,590	4,364	3,715,400	219,760
1978	87,740	4,574	3,836,200	222,095
1979	92,020	4,689	3,979,200	224,567
1980	90,470	4,664	4,132,400	227,225
1981	90,340	4,746	4,229,300	229,466
1982	90,880	4,644	4,276,500	231,664
1983	93,890	4,825	4,307,200	233,792
1984	98,480	5,123	4,354,100	235,825
1985	100,090	5,286	4,415,800	237,924
1986	105,800	5,440	4,462,200	240,133
1987	108,480	5,607	4,527,100	242,289
1988	113,050	5,827	4,616,900	244,499
1989	118,740	5,975	4,728,100	246,819
1990	123,550	6,048	4,866,700	249,399
1991	126,500	6,011	5,000,400	252,137
1992	131,110	6,149	5,116,700	255,078
1993	*135,197*	6,341	5,240,900	257,908

Note: Values in italics have been estimated by WSEO from comparable data.

Year	Residential Households	Non-Manufacturing Employment	Manufacturing Gross Product (million 1993$)	1993 Price Deflator
1970	1,105,587	1,010,413	*21,453*	0.280709
1971	*1,126,149*	1,005,375	*19,989*	0.294095
1972	1,148,000	1,020,151	*20,390*	0.305709
1973	1,173,000	1,065,259	*21,957*	0.323032
1974	1,217,000	1,114,246	*22,717*	0.355512
1975	1,252,000	1,148,686	*22,822*	0.384646
1976	1,293,000	1,199,730	*24,193*	0.407480
1977	1,332,000	1,255,333	25,180	0.436024
1978	1,392,000	1,328,044	27,760	0.467717
1979	*1,472,256*	1,393,513	29,480	0.509252
1980	1,540,510	1,443,287	27,610	0.562402
1981	1,588,990	1,470,222	25,660	0.612402
1982	1,602,698	1,479,614	25,120	0.647244
1983	1,607,643	1,524,112	24,560	0.678347
1984	1,639,572	1,585,722	26,060	0.705512
1985	1,670,475	1,650,006	25,410	0.732874
1986	1,699,633	1,706,051	27,880	0.755906
1987	1,735,783	1,787,791	28,910	0.787402
1988	1,787,028	1,870,917	30,260	0.820669
1989	1,833,019	1,932,376	32,250	0.860433
1990	1,872,431	2,036,994	33,600	0.905512
1991	1,922,000	2,102,238	32,140	0.944685
1992	1,977,000	2,143,941	32,170	0.973032
1993	2,018,000	2,187,057	*31,798*	1.000000

Note: Values in italics have been estimated by WSEO from comparable data.

APPENDIX D: ABOUT THE DATA

Data Analysis and Assumptions

End-Use Energy Consumption

All end-use energy consumption data are directly from Energy Information Administration sources (EIA). EIA petroleum end-use energy consumption data are modified for use in the Energy Use Profile to exclude non-energy uses of petroleum. These uses include asphalt and road oil, lubricants and other petroleum products (petroleum feedstocks for products such as paint).

Energy Expenditures

All end-use energy expenditure data are directly from EIA sources. EIA petroleum end-use energy expenditure data are modified for use in the Energy Use Profile to exclude non-energy uses of petroleum. These uses include asphalt and road oil, lubricants and other petroleum products (petroleum feedstocks for products such as paint).

Energy Prices

Energy prices are calculated by dividing end-use energy expenditures by end-use energy consumption. Energy end-use consumption and expenditure data are from EIA with non-energy uses of petroleum excluded as noted above.

Primary Energy Consumption

Primary energy consumption includes the energy consumed to produce electricity as well as that consumed by end-users. Primary energy consumption data are from the EIA. The Energy Use Profile uses a different energy conversion factor than EIA for determining the primary energy consumption at a hydroelectric plant. EIA treats hydroelectric plants like other fossil fuel generation plants in converting electricity output to fuel input. The conversion factor for these plants is approximately 33 percent (33 percent of the fuel input is converted to electricity). The Energy Use Profile uses a conversion factor of 100 percent for a hydroelectric plant. This avoids implying large energy losses at a hydroelectric plant (as the EIA conversion factor does) that do not exist. This results in Profile estimates of primary energy consumption for Washington that are significantly lower than EIA because the state has a large supply of electricity from hydroelectric plants.

Price Deflators

A price deflator for personal consumption was used to convert all expenditure and cost data to constant 1993 dollars. The price deflator was from the Washington Economic and Revenue Forecast.

Residential Sector Indices

The indices for the residential sector use residential households as the denominator. All household data are from the U.S. Bureau of the Census. Values for 1971 and 1979 were not available. The households for these years were interpolated from the surrounding years data and the trends in residential electric customers for those years. Energy consumption and expenditures for the residential sector are taken directly from EIA.

Commercial Sector Indices

The indices for the commercial sector use commercial employees as the denominator. Data on employment in Washington are from the U.S. Department of Commerce. Commercial employees (non-manufacturing employees) include wholesale and retail trade, financial, real estate and other services, and government employment. It does not include agriculture, forestry, fishing, mining, manufacturing, construction, or transportation. Energy consumption and expenditures for the commercial sector are taken directly from EIA.

Industrial Sector Indices

The indices for the industrial sector use industrial gross dollars of product as the denominator. Data on gross dollars of product are from the U.S. Department of Commerce. The manufacturing gross dollars of product includes agriculture, forestry, fishing, mining, manufacturing, and construction. Data were not available for 1993 or for 1970 to 1976. Manufacturing gross dollars of product were estimated for these years based on the trends in manufacturing employment for these years. Trends in manufacturing gross dollars of product and employment were very similar for the years when both data sources were available. Energy consumption and expenditures for the industrial sector are taken directly from EIA.

Transportation Sector Indices

The transportation sector indices use highway energy consumption and expenditures. Highway energy consumption and expenditures include all gasoline and diesel used in the transportation sector. This necessarily includes small amounts of diesel used by trains and ferries. It does not include alternative vehicle fuels such as natural gas or electricity. Highway consumption and expenditures are used to be as consistent as possible with the other component of the indices, which is vehicle miles traveled. This includes only vehicle travel on roads.

Greenhouse Gas Emissions

Greenhouse gas emissions are calculated using emission factors from the U.S. Department of Energy. Primary energy consumption for each fuel in Washington State is multiplied by the emission factor for that fuel to determine carbon dioxide emissions. Carbon dioxide is the major greenhouse gas produced during the combustion of energy fuels. Note that this calculation does not include the greenhouse gas emissions from power plants outside the state for electric utilities that serve customers inside Washington. It does include the emissions from power plants inside the state that produce electricity for utilities that serve customers outside Washington. Given that the electric grid throughout the Western United States is interconnected and greenhouse gases are a global phenomenon, it is difficult to look at greenhouse gases for a particular state.

Energy and the Economy Indicator

Washington State gross product was used for the energy and the economy indicator. These data are from the U.S. Department of Commerce. Data were not available for 1993 or for 1970 to 1976. Washington State gross state product was estimated for these years based on the trends in U.S. gross domestic product for these years. Trends in gross state product and gross domestic product were very similar for the years when both data sources were available.

Data Sources

Energy Consumption and Expenditure Data

State Energy Data System 1993
Energy Information Administration
U. S. Department of Energy
- obtained in electronic form from the EIA CD-ROM Energy InfoDisc

Wood Energy Consumption Data

Washington State Energy Office Estimates

Economic and Demographic Data

Gross State Product and employment data

Regional Economic Information System, 1969-1993
U. S. Department of Commerce
Economic and Statistics Administration
Bureau of Economic Analysis
Regional Economic Measurement Division
- obtained in electronic form from REIS CD-ROM 1969-1993

Implicit Price Deflator for Personal Consumption

Washington Economic and Revenue Forecast. Office of the Forecast Council. June 1995.
v XVIII, No. 2. Appendix Table 4.1, p. 135.

Households and State population

Bureau of the Census
Demographics and Population Division
U. S. Department of Commerce
- obtained from world wide web site

Carbon Dioxide Emission Factors

Sector-Specific Issues and Reporting Methodologies Support the General Guidelines for the Voluntary Reporting of Greenhouse Gases under Section 1605(b) of the Energy Policy Act of 1992. Volume 1, Appendix B. United States Department of Energy. October 1984.

Vehicle Miles Traveled

Washington State Department of Transportation. *Key Facts: A Summary of Useful Transportation Information.*

- Latest issue used - August 1995.

Conversion Factors

American Gas Association. *Gas Facts, A Statistical Record of the Gas Utility Industry.* Published annually.

- Latest issue used - 1991.

U.S. Department of Energy. *Annual Energy Review.* DOE/EIA-0384. Published annually.

- Latest issue used - May 1991.

U.S. Department of Energy. *State Energy Data Report, Consumption Estimates.* EIA-0214(93). July 1995.

Equivalent Units and Conversion Factors

Equivalent Units

Industry often uses *B* for billion, *mm* for million and *M* for thousand. The *Energy Use Profile* uses the following symbols:

k (kilo)	= thousand	= 10^3	1 therm	= 100,000 Btu
M (mega)	= million	= 10^6	1 short ton	= 2,000 pounds
G (giga)	= billion	= 10^9	1 metric ton	= 10^3kg = 2,204.62 pounds
T (tera)	= trillion	= 10^{12}	1 dry ton	= 2,000 pounds dried material
10^6 Btu	= 1 Mbtu	= 1,000 kBtu	1 barrel	= 42 gallons
10^9 Btu	= 1 Gbtu	= 1,000 Mbtu		

Conversion Factors

Energy conversion factors are fairly consistent over time; however, they may differ slightly due to changes in the average quality of fuels.

Petroleum

Mbtu per barrel and kBtu per gallon

Product	MBtu/Barrel	kBtu/Gallon
Aviation gas	5.048	120.19
Butane	4.326	103.00
Distillate fuel oil (diesel)	5.825	138.69
Kerosene-type jet fuel	5.670	135.00
Naptha-type jet fuel	5.355	127.50
Kerosene	5.670	135.00
Motor gasoline	5.253	125.05
Propane(LPG)	3.836	91.33
Residual oil	6.287	149.69
Methanol	2.839	67.60
Ethanol	3.545	84.40

Natural Gas

1000 Btu per cubic foot (CF)

	Washington		United States	
	Non-Electric Utility	Electric Utility	Non-Electric Utility	Electric Utility
1970	1.055	NA	1.025	1.029
1971	1.055	NA	1.026	1.029
1972	1.055	NA	1.026	1.027
1973	1.051	NA	1.025	1.021
1974	1.047	NA	1.025	1.020
1975	1.042	NA	1.022	1.023
1076	1.041	NA	1.021	1.023
1977	1.045	NA	1.022	1.028
1978	1.048	1.030	1.020	1.033
1979	1.047	1.030	1.020	1.033
1980	1.052	1.030	1.024	1.033
1981	1.050	1.031	1.026	1.033
1982	1.053	1.033	1.027	1.034
1983	1.043	1.033	1.031	1.028
1984	1.045	1.033	1.030	1.033
1985	1.040	1.033	1.032	1.037
1986	1.029	1.033	1.030	1.033
1987	1.033	1.033	1.031	1.032
1988	1.026	1.033	1.030	1.027
1989	1.032	1.033	1.032	1.027
1990	1.030	1.033	1.031	1.027
1991	1.031	1.050	1.031	1.023
1992	1.032	1.050	1.032	1.023
1993	1.037	1.050	1.029	1.023

Electricity

1 kWh (kilowatt-hour)	=	3,412 Btu (consumed)
1 Mwh (megawatt-hour)	=	10^3 kWh
1 Gwh (gigawatt-hour)	=	10^3 MWh = 10^6 kWh
1 kWa = 1 average kilowatt	=	8,760 kWh (annualized)
1 MWa = 1 average megawatt	=	8,760 MWh (annualized)

Coal

U.S. average: 1 short ton	=	21.4 MBtu
Utah coal: 1 short ton	=	22.6 MBtu
Centralia coal: 1 short ton	=	16.0 Mbtu

Wood

1 dry ton = 17.2 Mbtu

APPENDIX E: GLOSSARY OF ENERGY TERMS

Anthracite. A hard, black lustrous coal containing a high percentage of fixed carbon and a low percentage of volatile matter. It is often referred to as hard coal.

Aviation Gasoline, Finished. All special grades of gasoline for use in aviation reciprocating engines.

Barrel. A volumetric unit of measure for crude oil and petroleum products equivalent to 42 U.S. gallons.

Bituminous Coal. A coal that is high in carbonaceous matter having a volatility greater than anthracite and a caloric value greater than lignite. In the United States, it is often referred to as soft coal.

Black Liquor. A source of energy in the paper industry consisting of spent cooking liquors from the kraft or sulfate pulping process, along with the lignin dissolved and removed from the wood.

British Thermal Unit (Btu). The amount of energy required to raise the temperature of one pound of water 1°F. An average Btu content of fuel is a heat value per unit quantity of fuel, as determined from tests of fuel samples.

Coal. All ranks of coal: anthracite, bituminous coal, and lignite.

Commercial Sector. Non-manufacturing business establishments, including hotels, motels, restaurants, wholesale businesses, retail stores, and other service enterprises; heath, social, and educational institutions; and federal, state, and local governments.

Crude Oil (including lease condensate). A mixture of hydrocarbons that exists in liquid phase in underground reservoirs and remains liquid at atmospheric pressure after passing through surface separating (refining) facilities. Included are lease condensate and liquid hydrocarbons produced from tar sands, gilsonite, and oil shale.

Diesel Fuel. See *Distillate fuel oil.*

Direct Service Industries (DSI). Industries that receive power directly from Bonneville Power Administration, primarily aluminum companies in the Northwest.

Distillate Fuel Oil. Light fuel oils distilled during the refining process and used primarily for space heating, on-and-off highway diesel engine fuel (including railroad engine fuel and fuel for agricultural machinery), and electric power generation. Included are products known as No.1, No.2, and No.4 fuel oils, and No.1, No.2, and No.4 diesel fuels. No.2 fuel oil is used in atomizing-type burners for domestic heating or for moderate commercial-industrial burner units. Diesel fuels are used in compression-ignition engines.

Dry Ton (wood). 2,000 pounds of material dried to a constant weight.

Electrical System Energy Losses. The amount of energy lost during generation, transmission, and distribution of electricity, including plant use and unaccounted for electrical energy.

Electricity Sales. The gross electricity output measured at the generator terminals, minus power plant use and transmission and distribution losses. Sectors generally covered are residential, commercial, industrial, and "other" sales.

Electric Utility. A corporation, agency, person, authority, or other entity that owns , or operates facilities for the generation, transmission, distribution, or sale of electricity.

Electric Utility Sector. Privately and publicly owned establishments that generate electricity primarily for use by the public.

End-Use Energy. Energy consumed by end-users in the end-use sectors.

End-Use Sector. The residential, commercial, industrial, and transportation sectors of the economy.

Fossil Fuels. Sources of energy from the earth, primarily crude oil, natural gas, and coal.

Fossil Fuel Steam Electric Plant. An electricity generation plant in which the prime mover is a turbine rotated by high pressure steam produced in a boiler by heat from burning fossil fuels.

Geothermal Energy. Hot water or steam extracted from geothermal reservoirs in the earth's crust that can be supplied to steam turbines at electric utilities to produce electricity, or used directly for localized space heating.

Gigawatt. One billion watts.

Gigawatt-Hour (Gwh). One billion watts for one hour.

Heating Oil. A distillate fuel oil for use in atomizing-type burners for domestic heating or for moderate-capacity commercial and industrial burner units. (See also *Distillate fuel oil.)*

Heavy Oil. No.4, No.5, and No. 6 fuel oils, crude oil, and topped crude oil used as fuel at electric utility generation plants. The term heavy oil is applied only to fuel consumed by the electric utility sector.

Hydroelectric Power. Electricity generated by an electric power plant whose turbines are driven by falling water.

Implicit Price Deflator. A measure over time of price changes of goods and services. Unlike the consumer price index, it is not based on a theoretical "market basket" of items, but rather consumption data in the National Income Accounts. For this reason, it reflects changes in the actual consumption pattern of the American consumer.

Industrial Sector. Manufacturing industries, which make up the largest part of the sector, along with mining, construction, agriculture, fisheries, and forestry. Establishments in the sector range from steel mills, to small farms, to companies assembling electronic components.

IOU. Investor-owned utility.

Jet Fuel. Includes both naptha-type and kerosene-type jet fuel. Although most jet fuel is used in aircraft, some is used for other purposes, such as fuel for turbines to produce electricity.

Kerosene. A petroleum middle distillate, with burning properties suitable for use as an illuminant when burned in wick lamps. Kerosene is used primarily in space heaters, cooking stoves, and water heaters.

Kilowatt. One thousands watts.

Kilowatt-Hour (kWh). One thousand watts for one hour.

Lease Condensate. A natural gas liquid recovered from gas-well gas in lease separators or natural gas field facilities. Lease condensate consists primarily of pentanes and heavier hydrocarbons. Generally, it is blended with crude oil for refining.

Light Oil. No. 1 and No. 2 fuel oils, kerosene, and jet fuel used by the electric utility sector. The term light oil is applied only to fuel used in the electric utility sector.

Lignite. A brownish-black coal of low rank with high inherent moisture content. It is also referred to as a brown coal.

Liquefied Petroleum Gases (LPG). Ethane, propane, normal butane, ethane-propane mixtures, propane-butane mixtures, and isobutane produced at natural gas processing plants. LPG also includes liquefied refinery gases (ethylene, propylene, butylene, and isobutylene) produced from crude oil at refineries.

Lubricants. Substances used to reduce friction between bearing surfaces. Petroleum lubricants may be produced from either distillates or residuals. Other substances may be added to impart or improve certain required properties.

Megawatt. One million watts.

MegaWatt-Hour (Mwh). One million watts for one hour.

Miscellaneous Petroleum Products. Includes all finished petroleum products not classified elsewhere, e.g., petrolatum, absorption oils, ram-jet fuel, rocket fuels, specialty oils, and medicinal oils.

Motor Gasoline, Finished. A complex mixture of relatively volatile hydrocarbons, with or without small quantities of additives, that have been blended to form a suitable fuel for spark-ignition engines. Included are gasohol and finished leaded and unleaded gasoline.

Natural Gas. A mixture of hydrocarbons and small quantities of various non-hydrocarbons existing in the gaseous phase or in solution with crude oil in underground reservoirs. The designation *dry* represents the marketable portion of natural gas production that is obtained by subtracting extraction losses, including natural gas liquids removed at processing plants, from total production.

Net Generation. Gross generation, less plant use, measured at the terminals of the station's step-up transformer. The energy required for pumping at pumped storage plants is regarded as plant use and must be deducted from gross generation.

Net Interstate Sales of Electricity. The difference between the sum of electricity sales and losses within a state and the total amount of electricity generated within the state.

Nominal Dollars. Dollars that have not been adjusted for the effects of inflation, or the price paid for a product or service at the time of the transaction.

Nuclear Energy. Electricity generated by an electric power plant whose turbines are driven by steam generated in a reactor by heat from the fissioning of nuclear fuel.

NWPPC. Northwest Power Planning Council.

Other Generation. Electricity originating from biomass, fuel cells, geothermal heat, solar power, waste, wind, or wood.

Personal Income. The sum of proprietor's income, wage and salary payments, other labor income, interest, dividends, rent, and transfer payments.

Petroleum. A generic term applied to oil and oil products in all forms, such as crude oil, lease condensate, unfinished oils, motor gasoline, distillate fuel oil (diesel), heavy oil, aviation gasoline, kerosene, and LPG.

Petroleum Products. Products obtained from the processing of crude oil, natural gas, and other hydrocarbon compounds.

Pipeline Fuel. Gas consumed in the operation of pipelines, primarily in compressors.

Primary Energy. All energy consumed by end users, excluding electricity but including the energy consumed at electric utilities to generate electricity. (In estimating energy expenditures, there are no fuel-associated expenditures for hydroelectric power, geothermal energy, solar energy, or wind energy, and the quantifiable expenditures for process fuel and intermediate products are excluded.)

Propane. A normally gaseous hydrocarbon extracted from natural gas or refinery gas streams. It is primarily used for residential and commercial heating and cooling, and also as a fuel for transportation. Industrial uses of propane include use as a petrochemical feedstock.

Real Dollars. Dollars that have been adjusted for the effects of inflation, using an index such as the implicit price deflator. (See *Implicit price deflator*.)

Renewable Resource. A resource that uses solar, wind, water (hydro), geothermal, biomass, or similar sources of energy, and that is used for electric power generation or for reducing the electric power requirement of a customer.

Residential Sector. All private residences, whether occupied or vacant, owned or rented, including single-family homes, multifamily housing units, and mobile homes. Secondary homes, such as summer homes, are also included. Institutional housing, such as school dormitories, hospitals, and military barracks, are included in the commercial sector.

Residual Fuel Oil. The heavier oils that remain after the distillate fuel oils and lighter hydrocarbons are distilled away in refinery operations.

Short Ton (coal). A unit of weight equal to 2,000 pounds.

Therm. 100,000 Btus. (See *British thermal unit*.)

Vehicle Miles Traveled: The miles of travel by vehicles on roads and highways.

Watt. The electrical unit used to measure the rate of doing work (power). Watts are used in the electrical field much as horsepower is used to measure power in the mechanical field.

Wood Energy. Wood and wood products used as fuel. Included are round wood (cord wood), limb wood, wood chips, bark, sawdust, forest residues, charcoal, pulp waste, and spent pulping liquor.